US006948425B2

(12) **United States Patent**
Dumenil

(10) **Patent No.: US 6,948,425 B2**
(45) **Date of Patent: Sep. 27, 2005**

(54) **MACHINE FOR PRINTING ON ARTICLES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/872,511**

(22) Filed: **Jun. 22, 2004**

(65) **Prior Publication Data**

US 2005/0087083 A1 Apr. 28, 2005

(30) **Foreign Application Priority Data**

Jun. 23, 2003 (FR) 03 07583

(51) **Int. Cl.**[7] **B41F 17/22**; B41F 17/18
(52) **U.S. Cl.** **101/38.1**; 101/39; 101/40; 101/41; 101/42; 101/43; 101/44; 101/40.1
(58) **Field of Search** 101/39–44, 38.1

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,553,085	A		5/1951	Groce	
3,955,496	A	*	5/1976	Urban	101/40
4,404,900	A	*	9/1983	Ozawa et al.	101/40
4,750,419	A	*	6/1988	Meredith	101/40
5,711,216	A		1/1998	Hellmeier et al.	
5,970,865	A	*	10/1999	Horth et al.	101/40
5,996,486	A		12/1999	Averill et al.	
6,164,199	A	*	12/2000	Dubuit et al.	101/38.1
6,823,781	B2	*	11/2004	Tweedy et al.	101/40.1

* cited by examiner

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(74) *Attorney, Agent, or Firm*—Young & Thompson

(57) **ABSTRACT**

A printer machine for printing on articles, includes a plurality of article-carriers suitable for moving in indexed manner in a plane around a circular path. Each article-carrier is stationary in an indexed position and mobile between the indexed positions, and a plurality of print stations distributed around the path in register with indexed positions of the article-carriers. Each article-carrier is fitted with an inlet shaft turnable about its own axis by drive elements, and with at least one outlet shaft for carrying an article and adapted to turn when the inlet shaft is turned. The inlet shaft of each article-carrier is adapted to turn in register with an indexed position, and to conserve the same angular orientation between print stations.

24 Claims, 17 Drawing Sheets

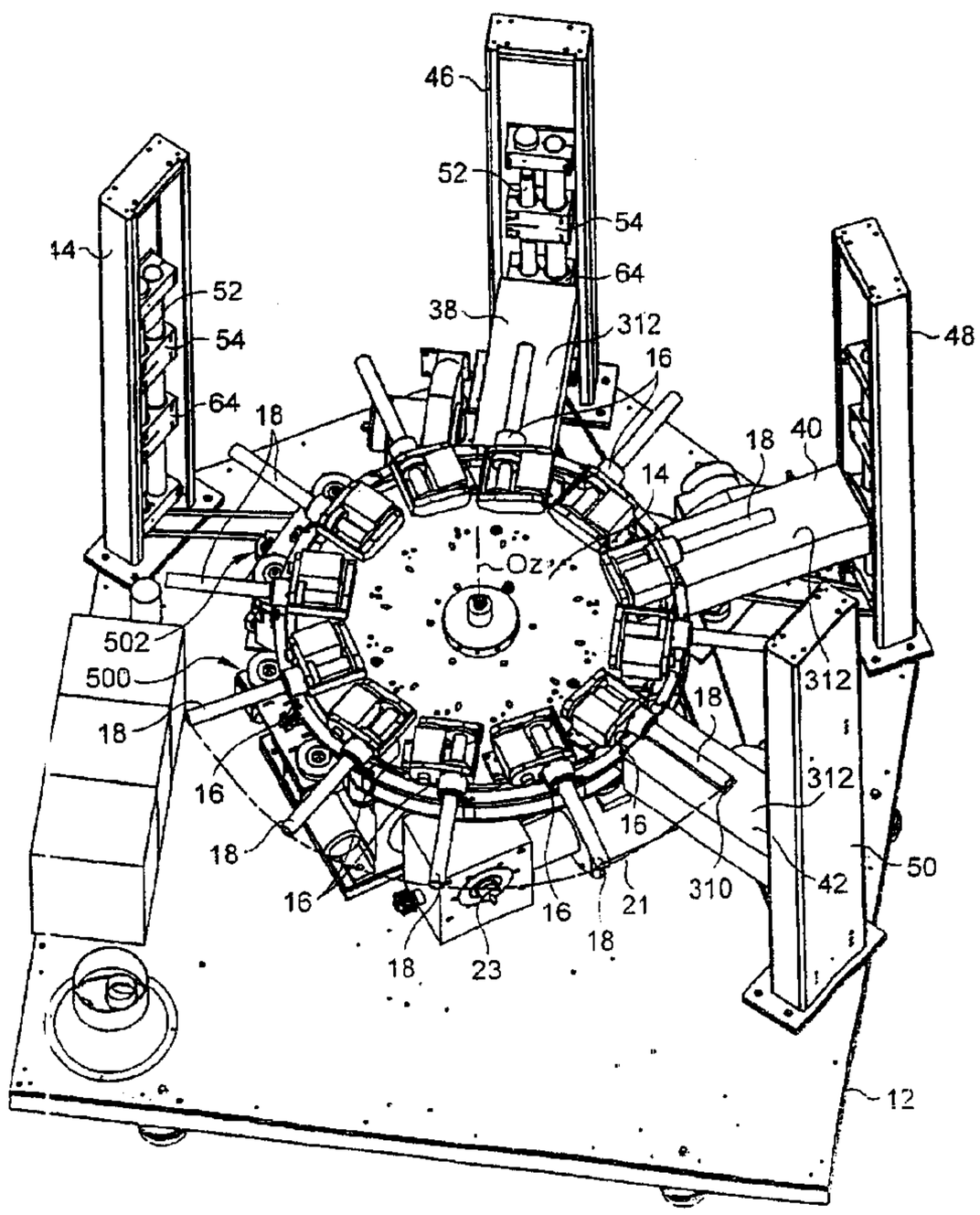

Fig.1

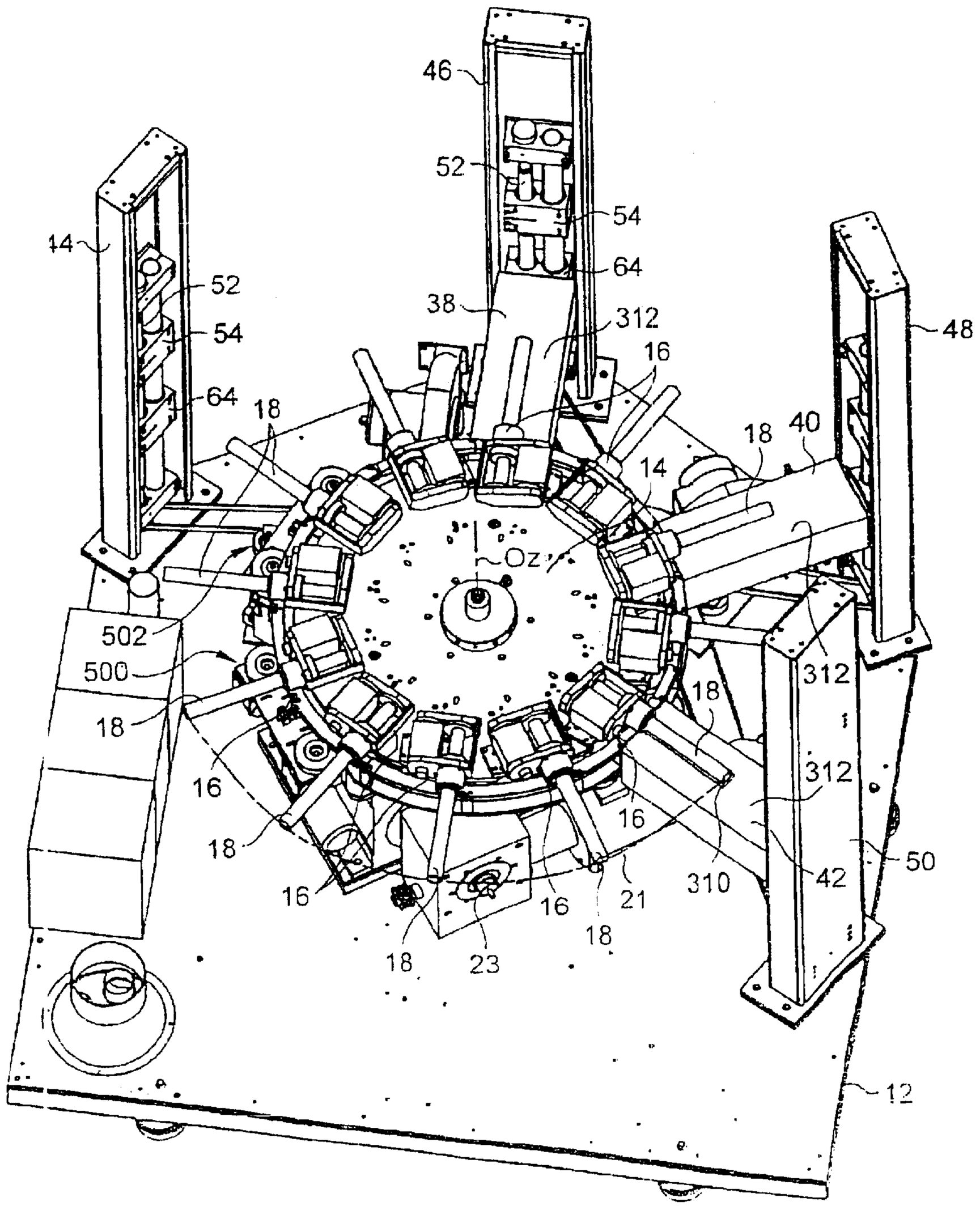
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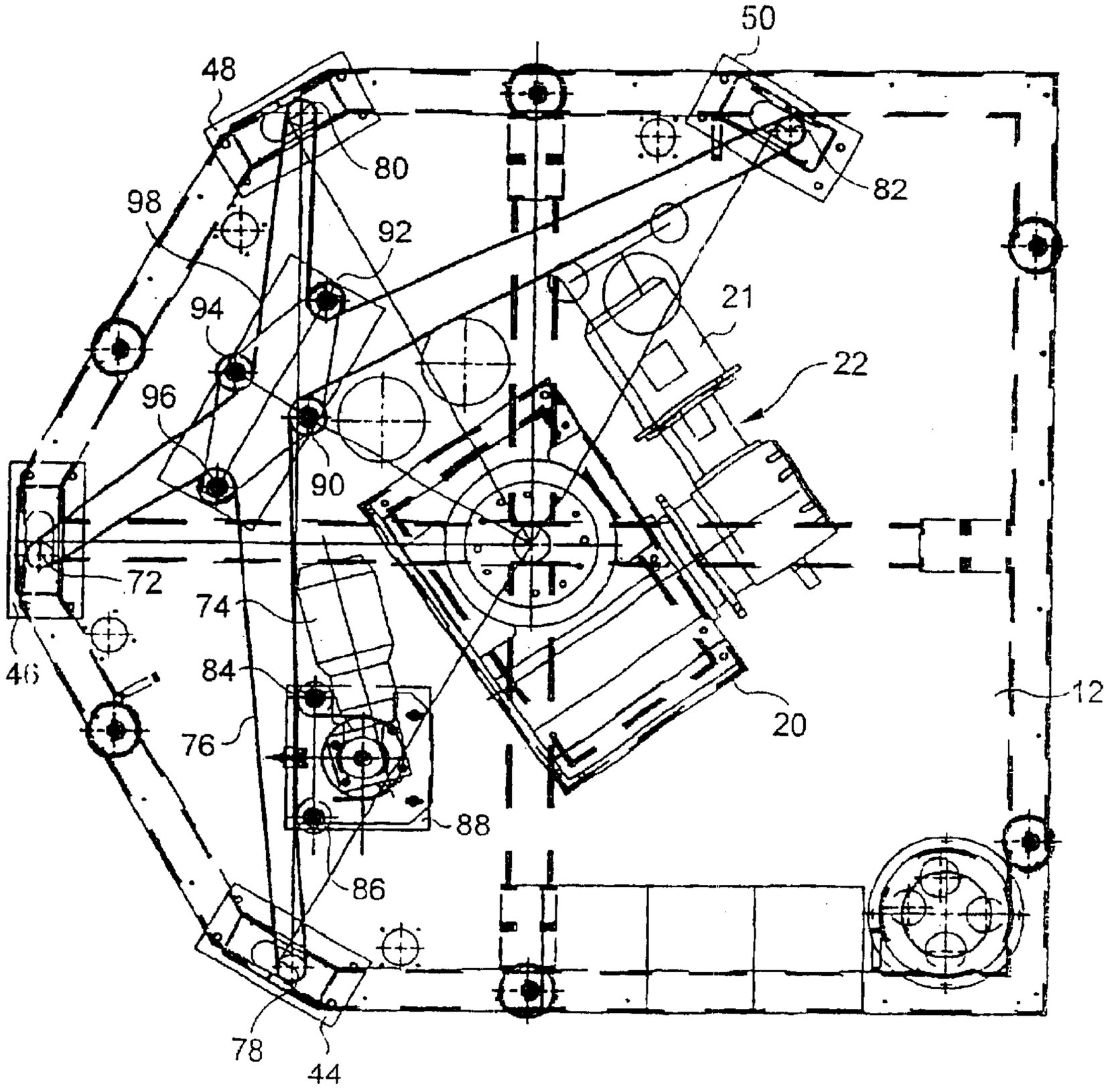
Fig.2



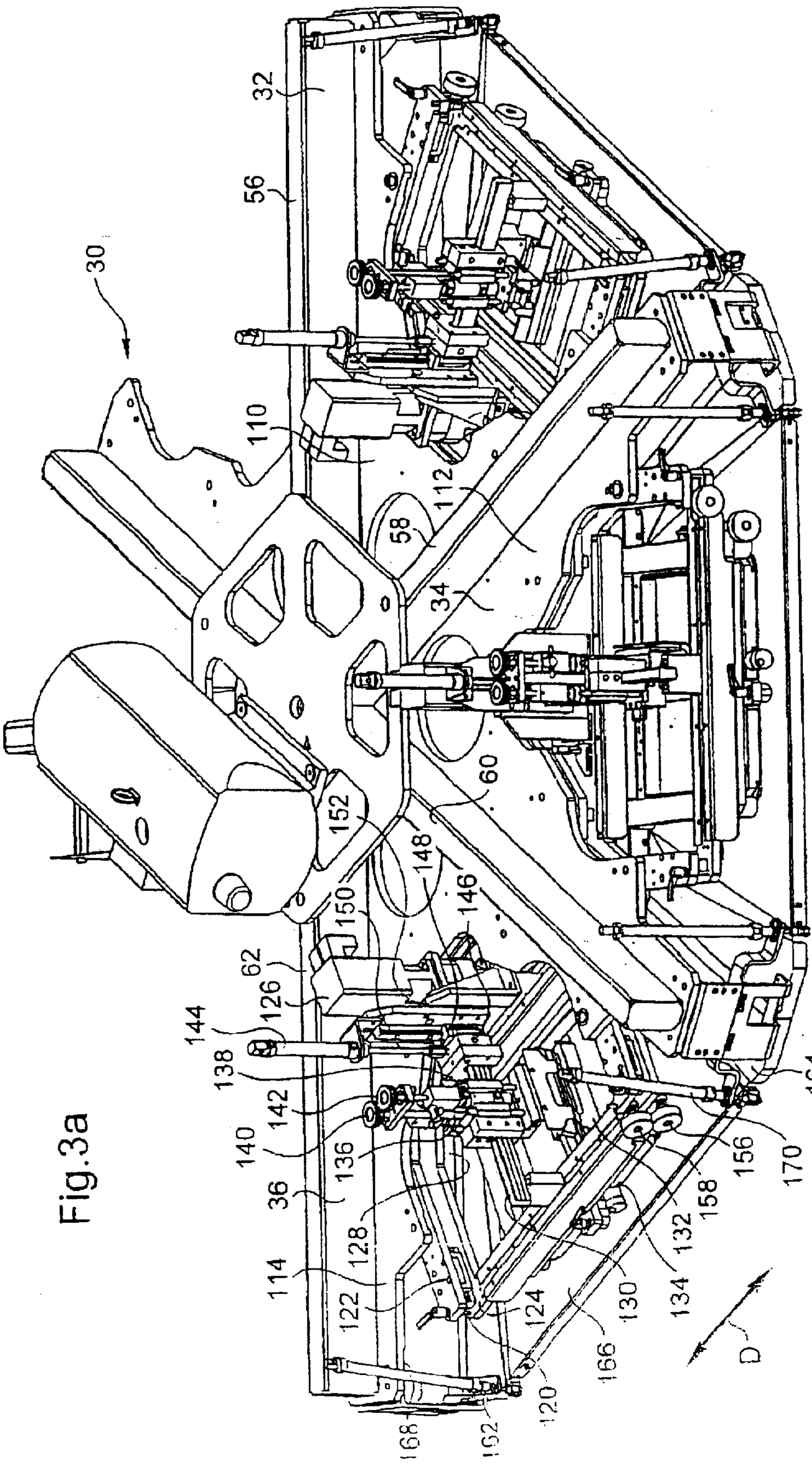

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Fig.3a

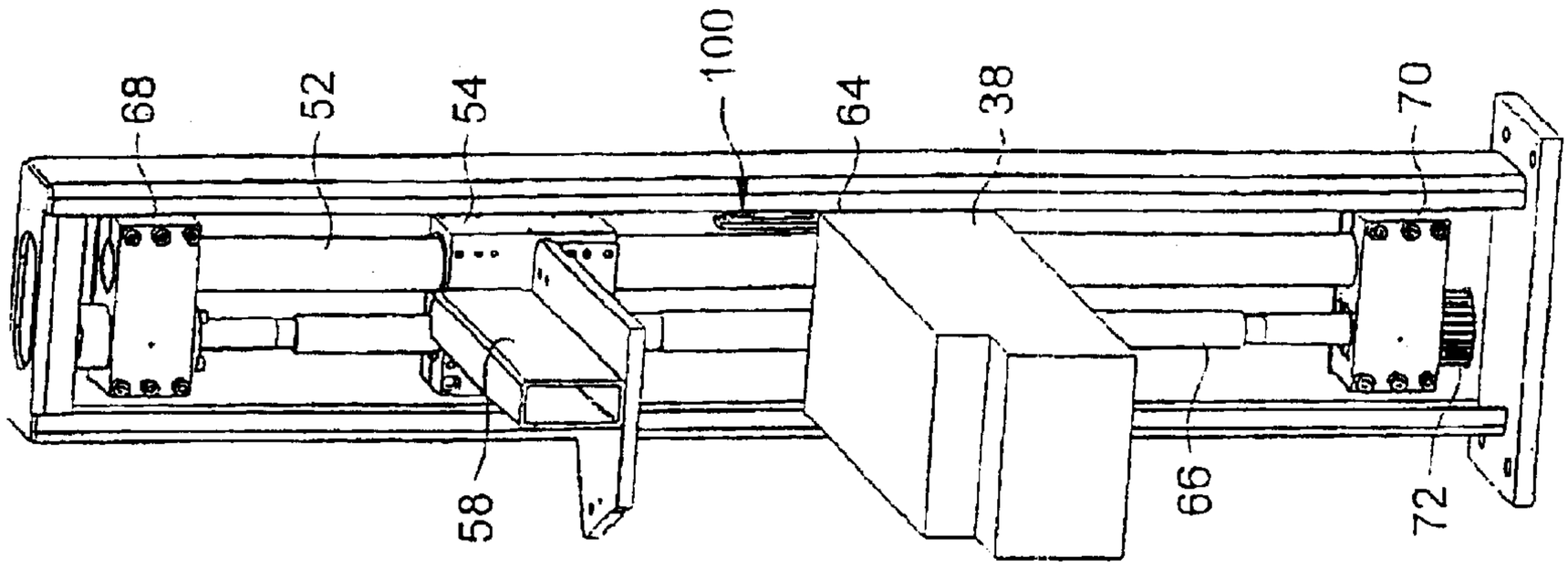
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Fig.4

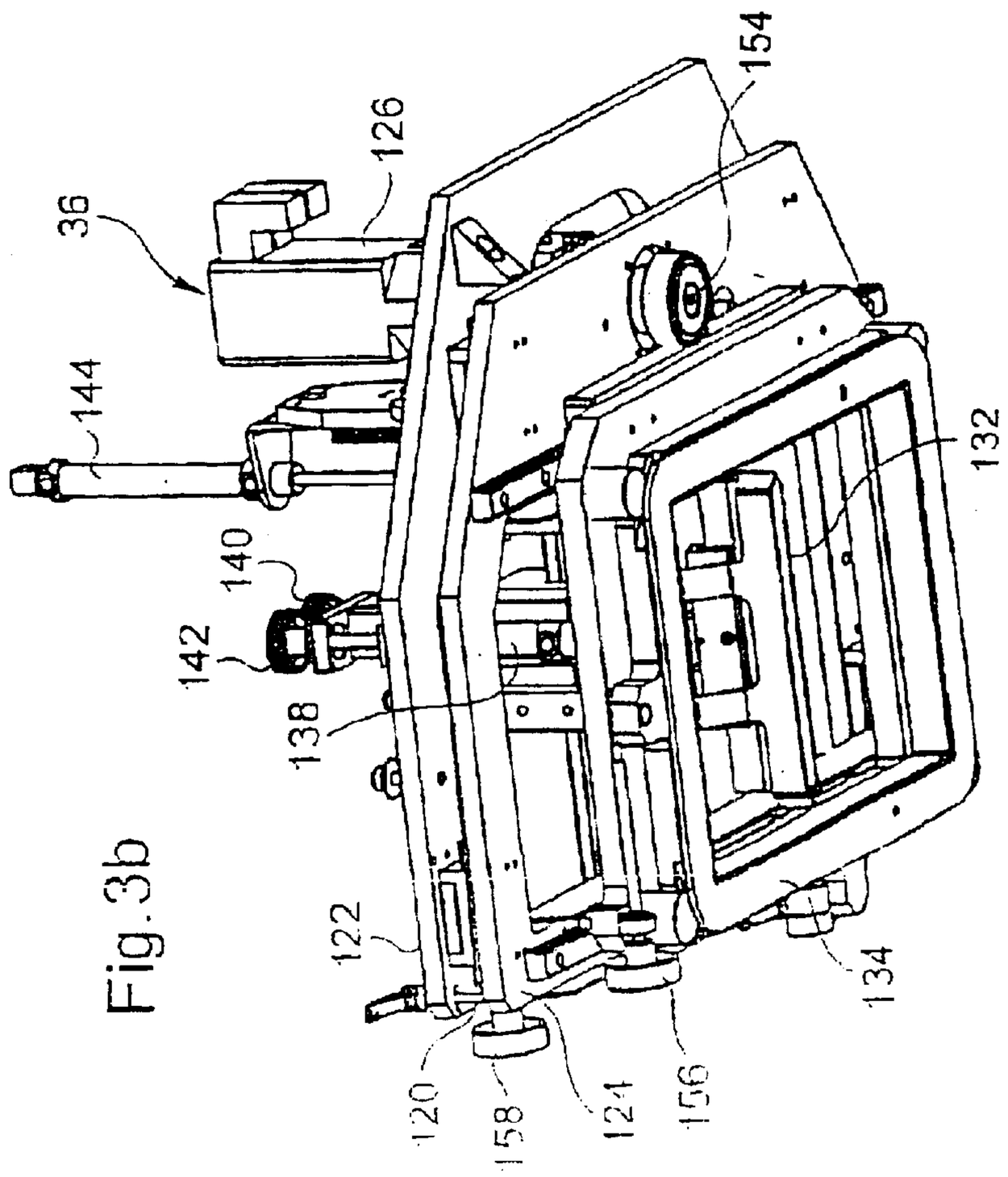
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Fig.3b

Fig.5

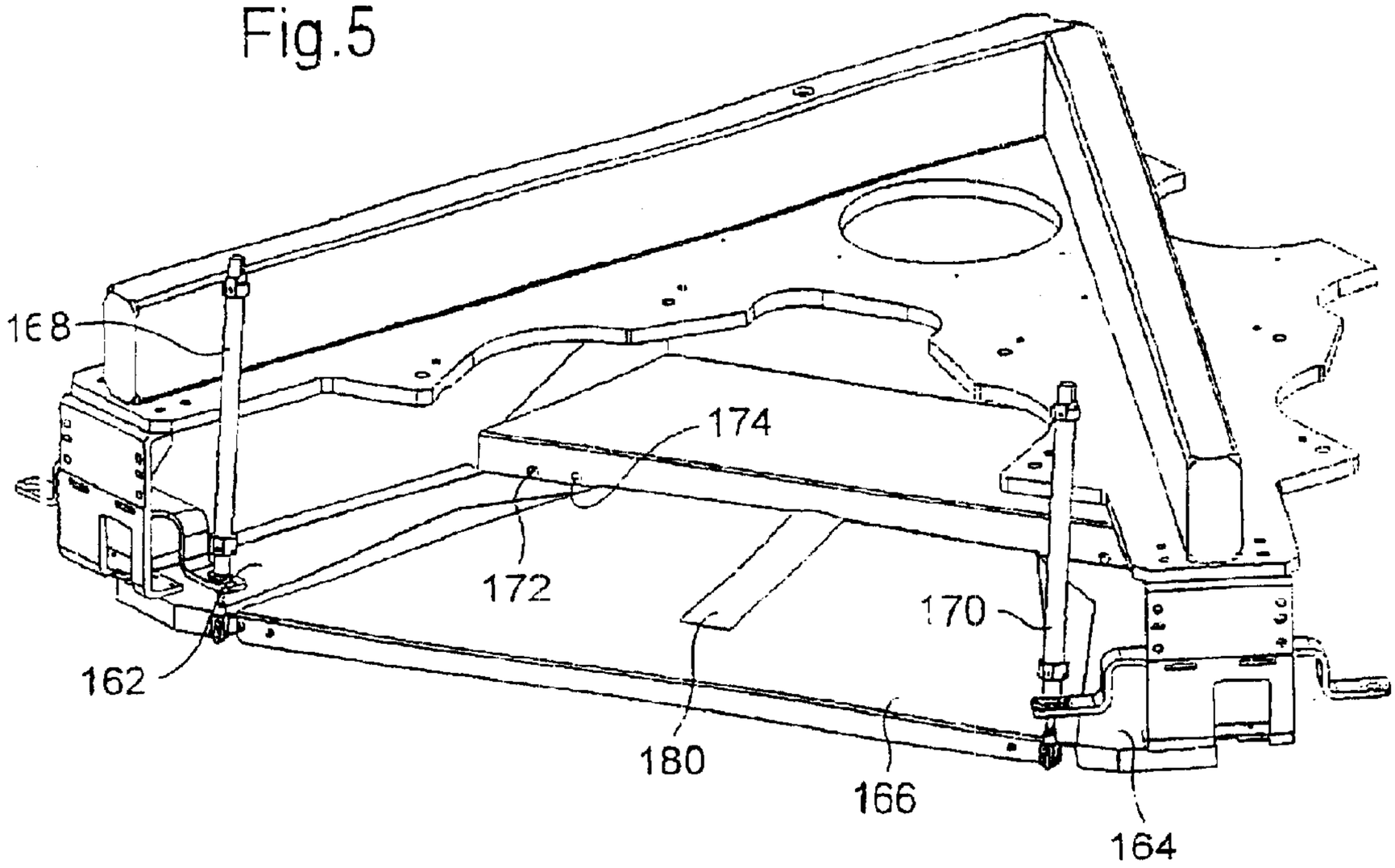
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Fig.6

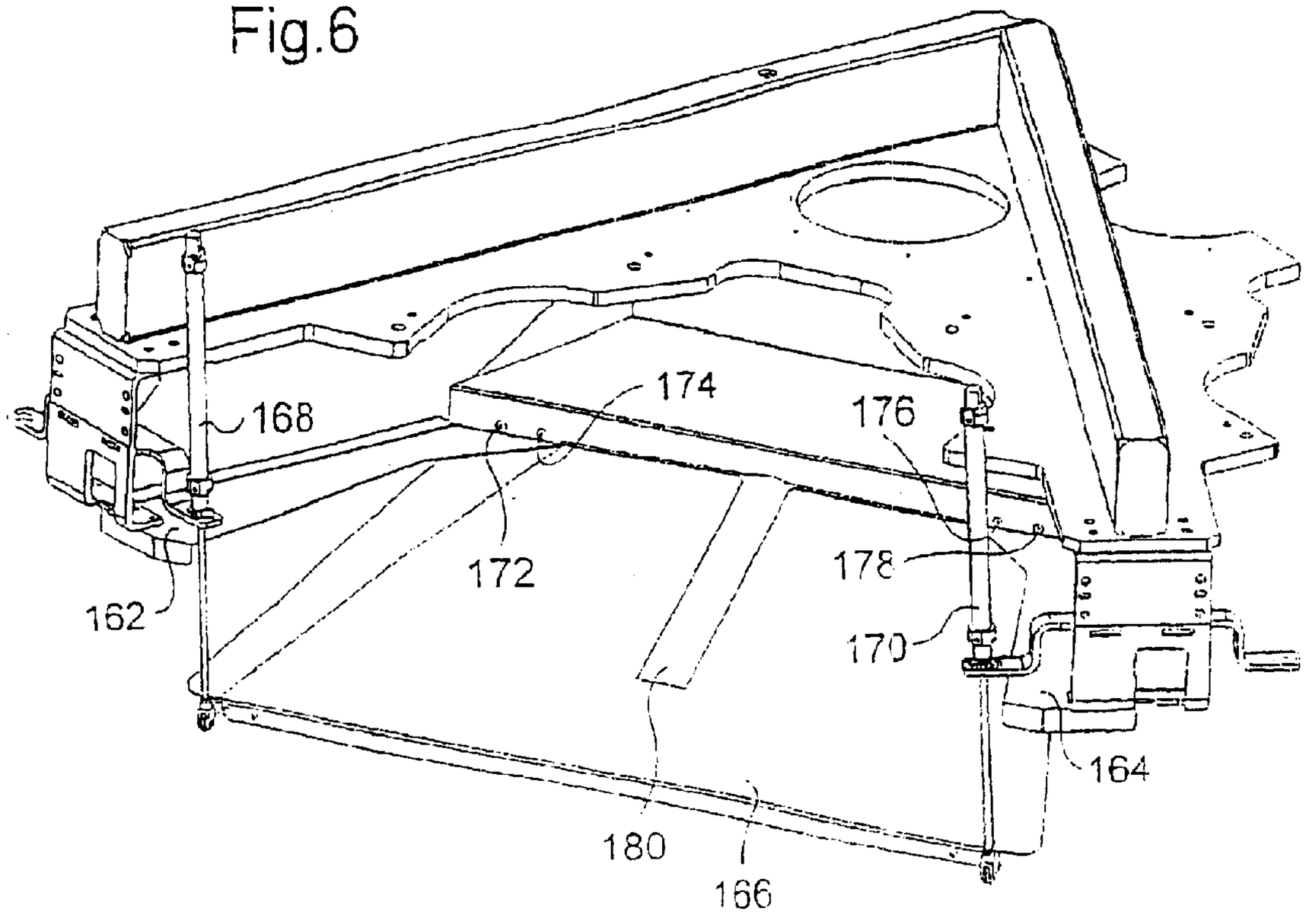
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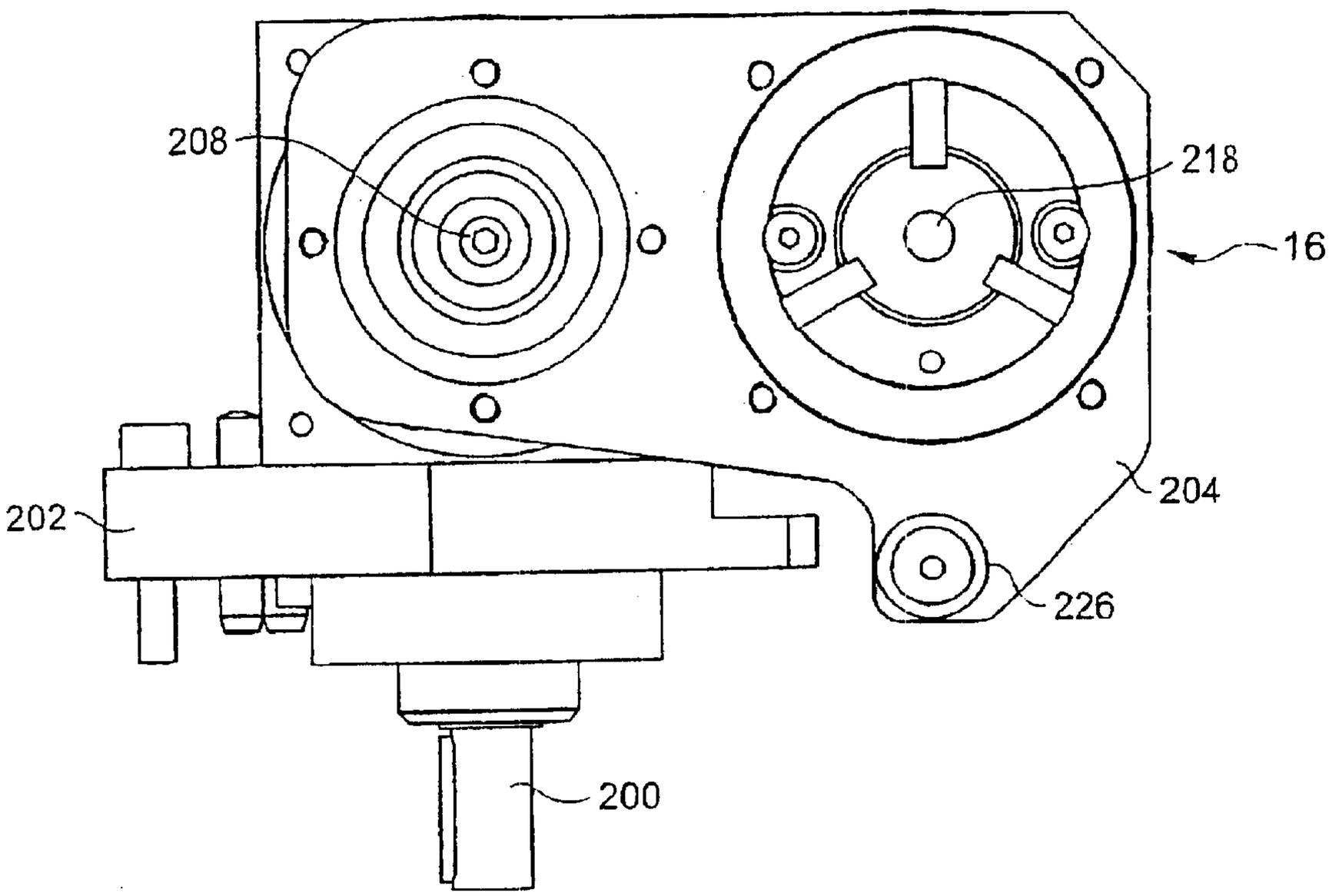
Fig.7



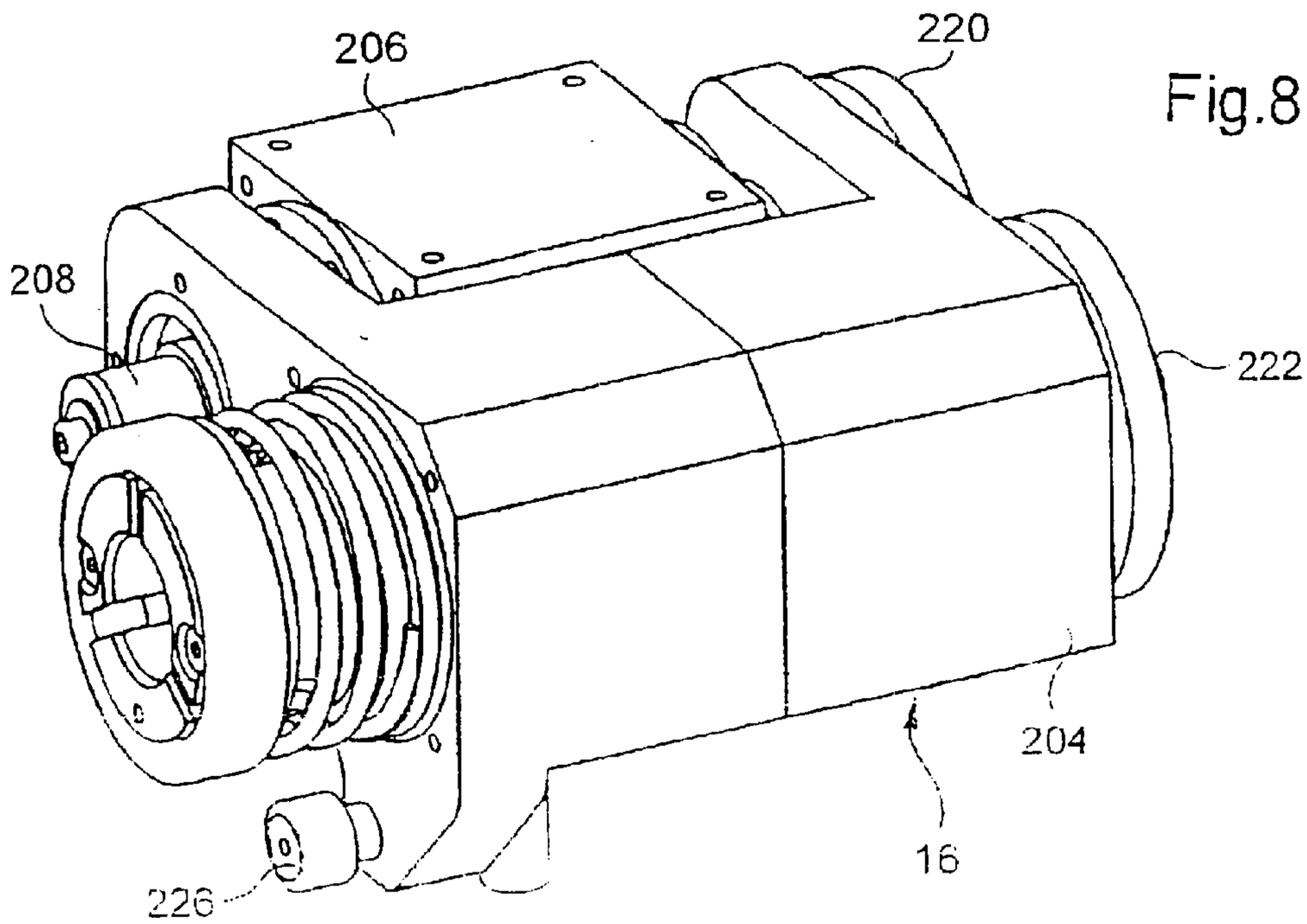


Fig.8

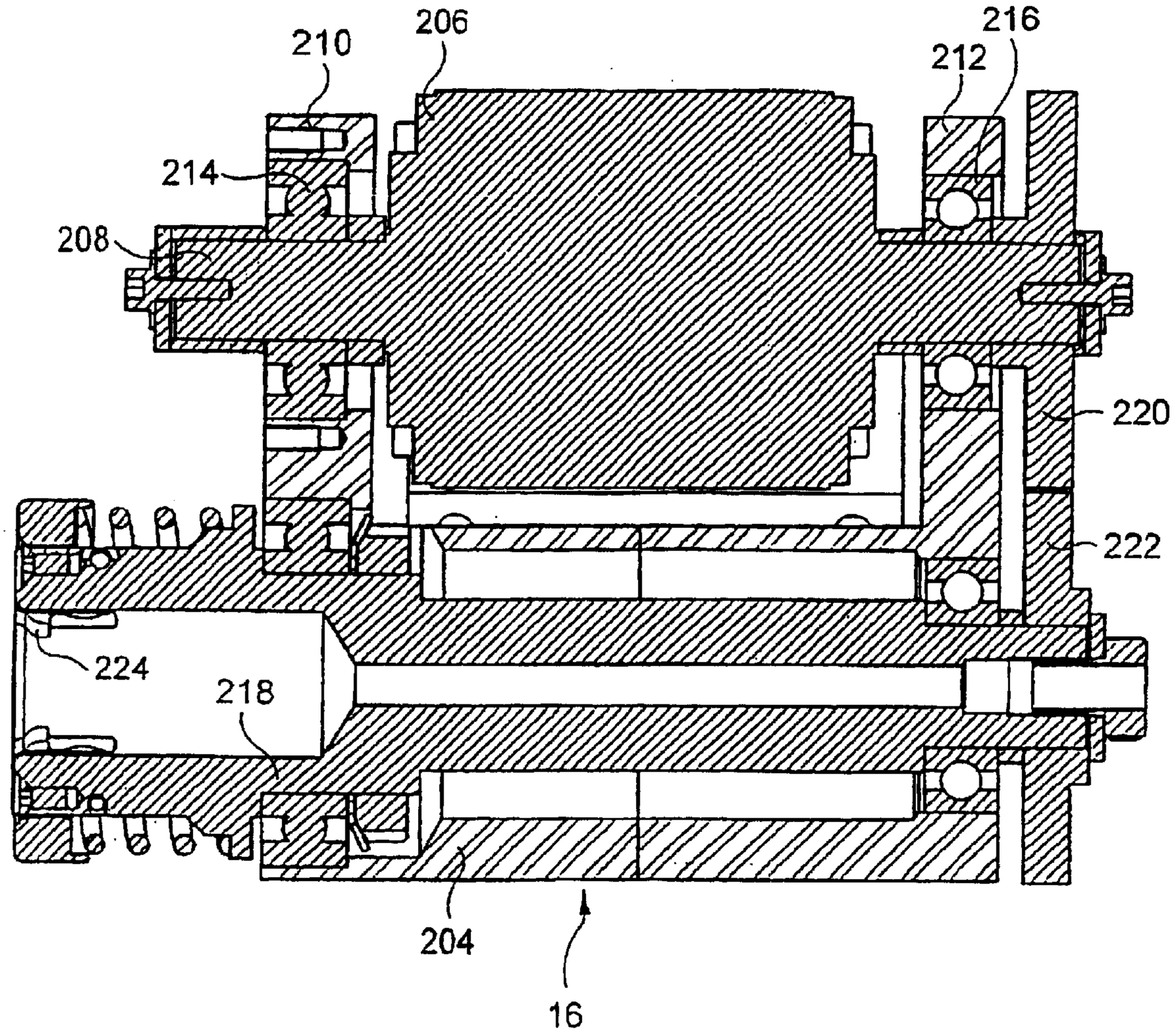


Fig.9

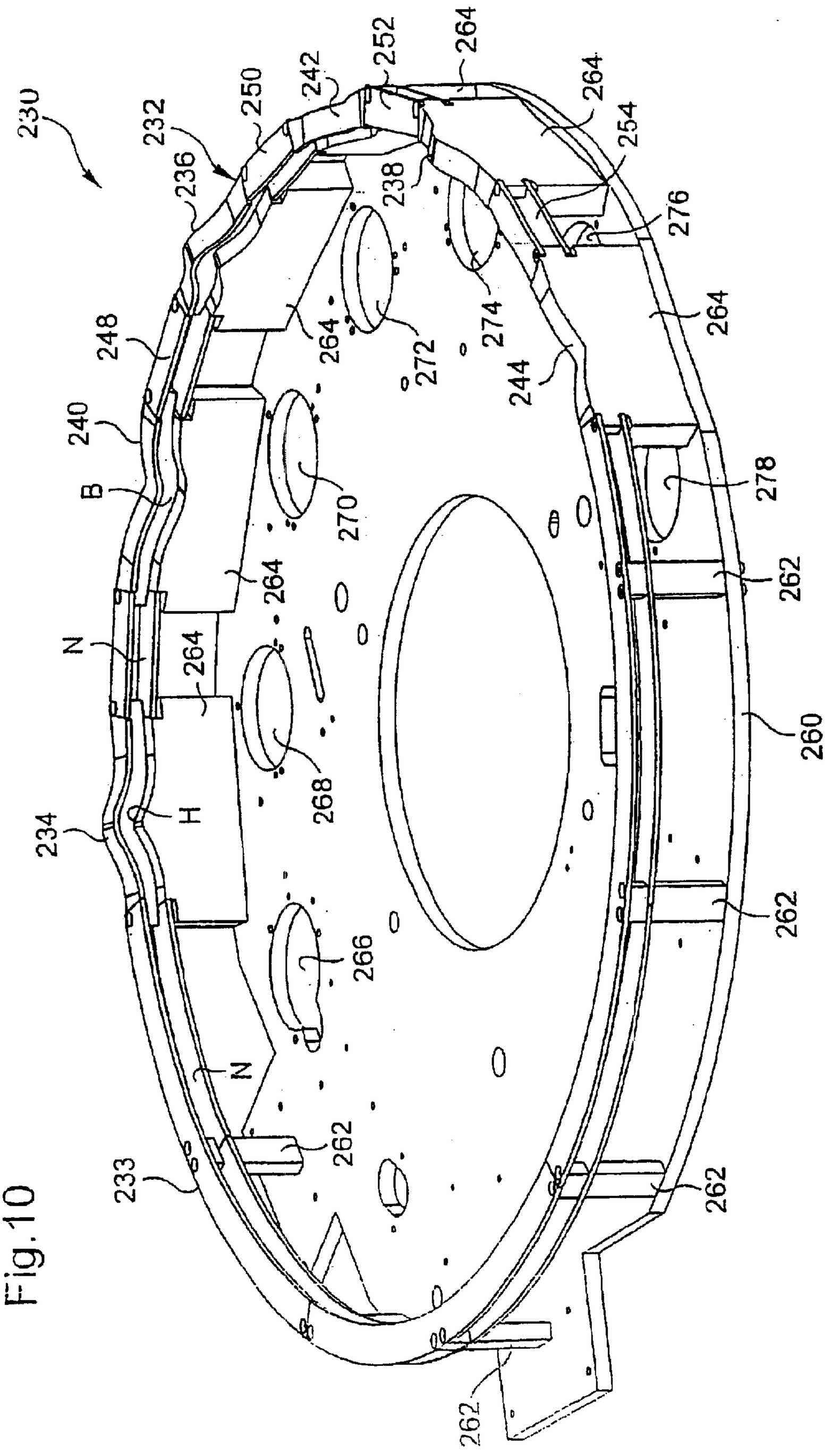

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Fig.10

Fig.11a

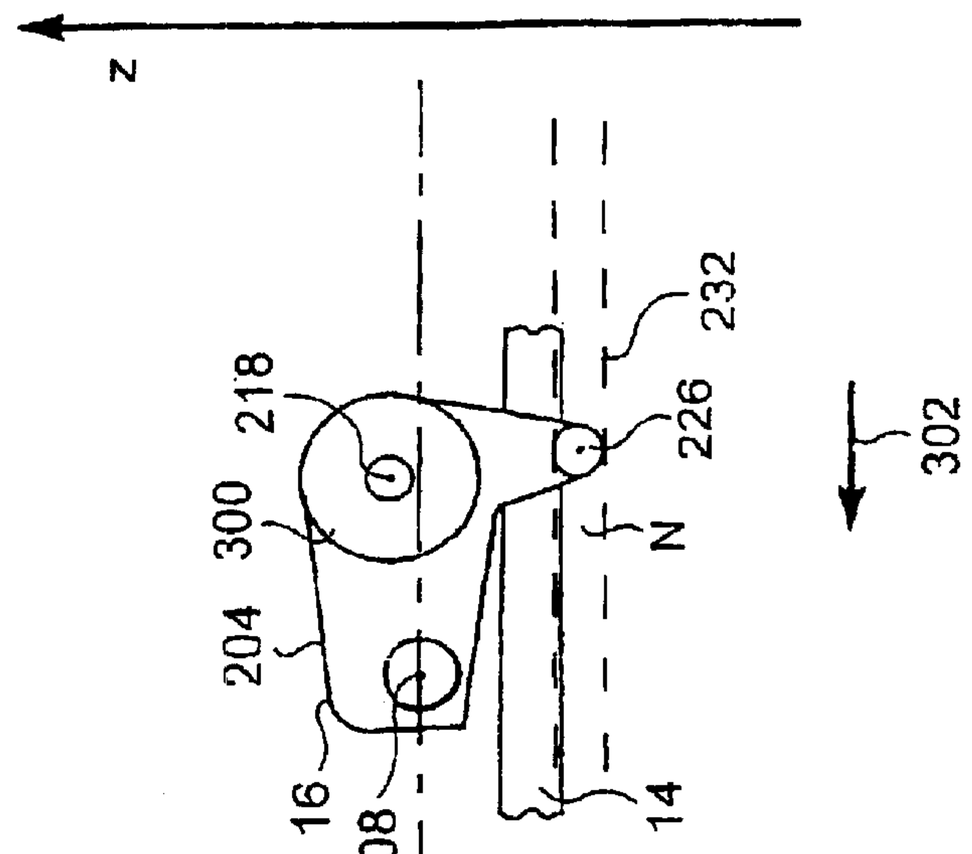


Fig.11b

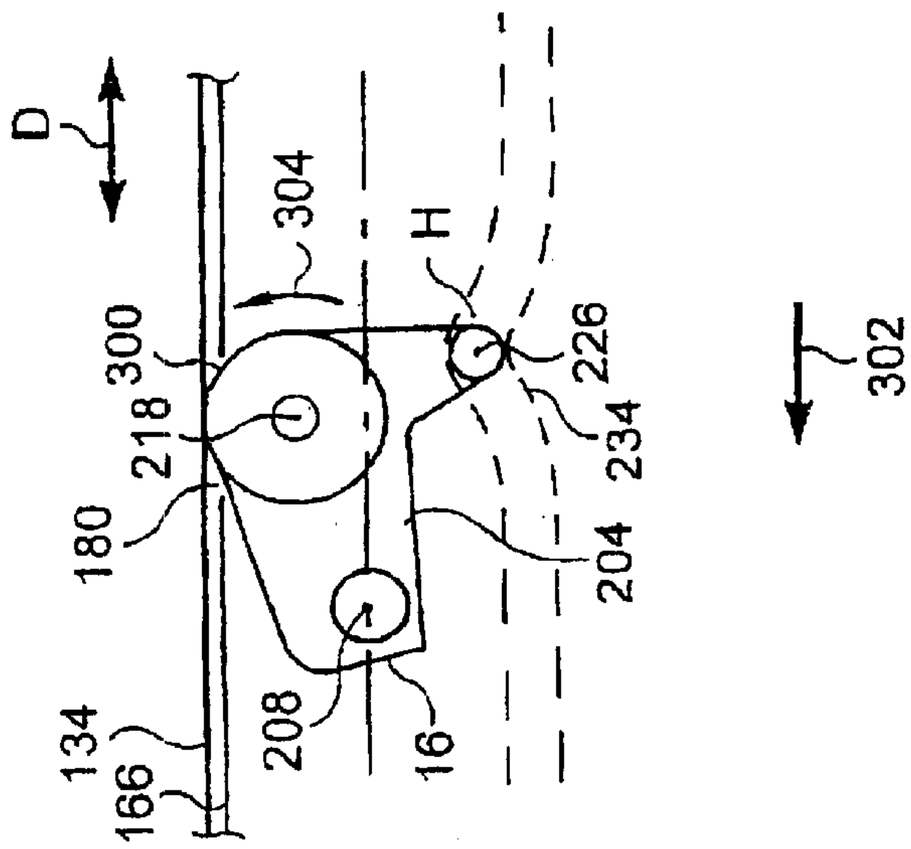
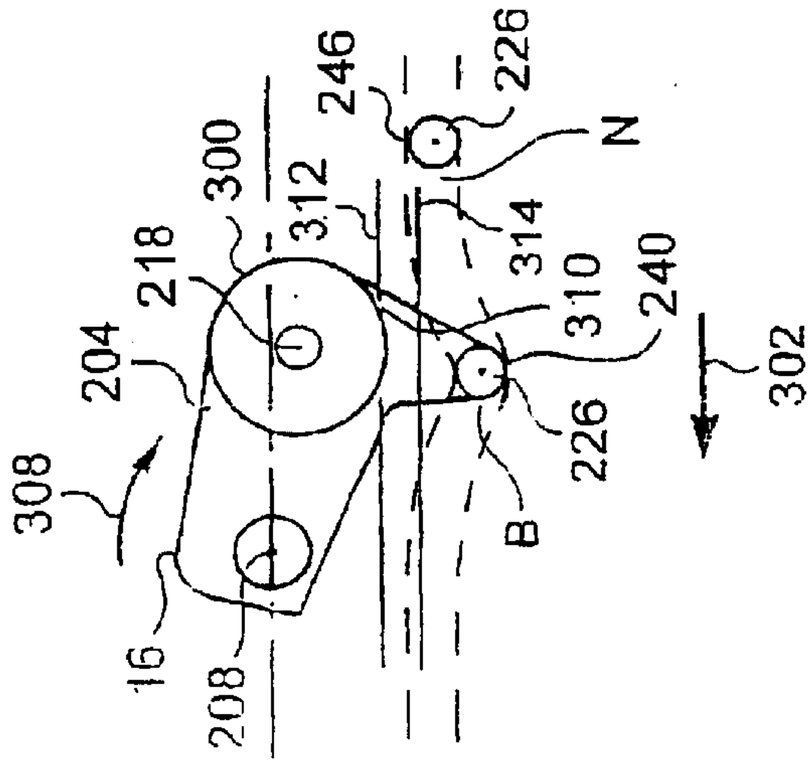


Fig.11c



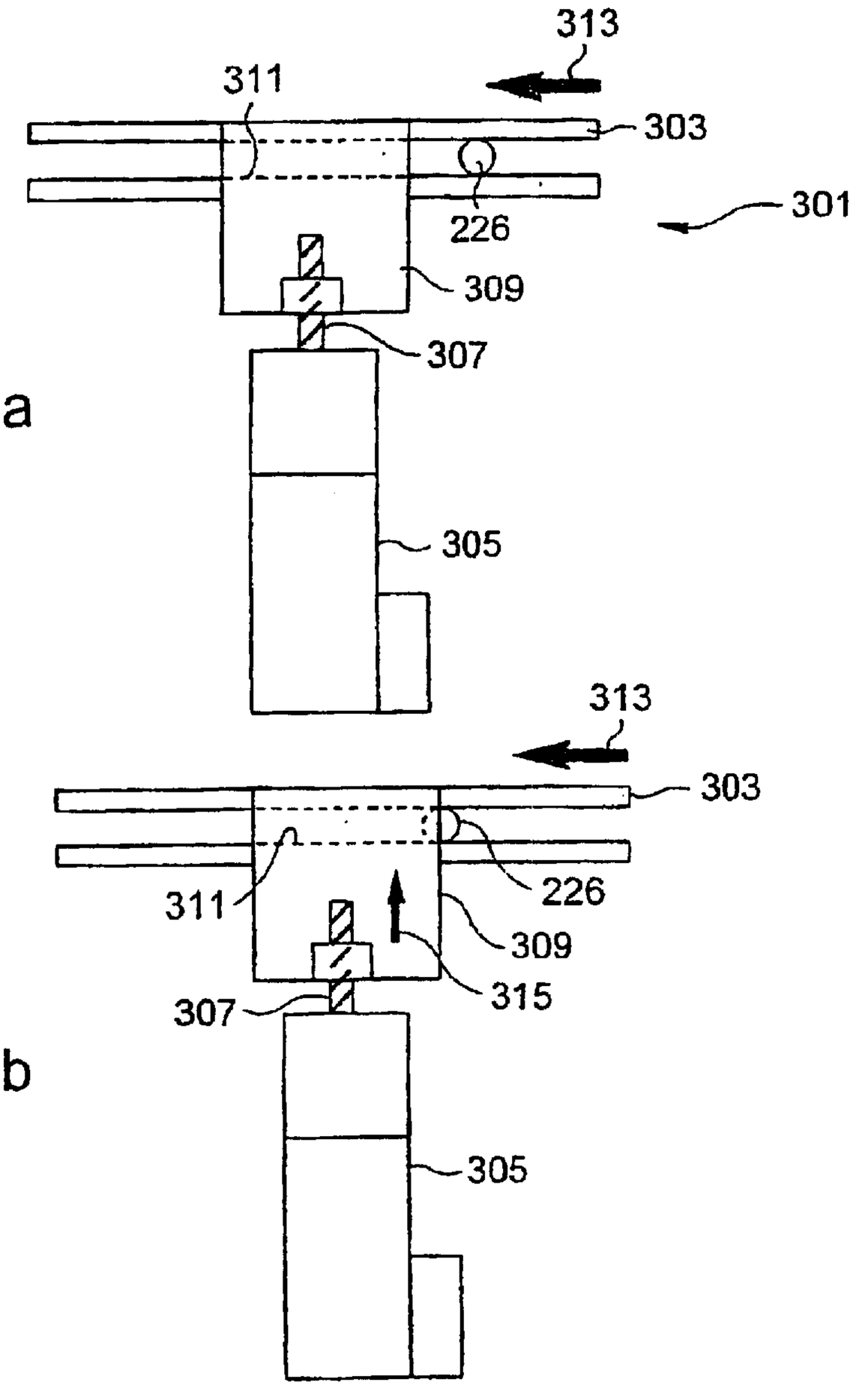


Fig.12a

Fig.12b

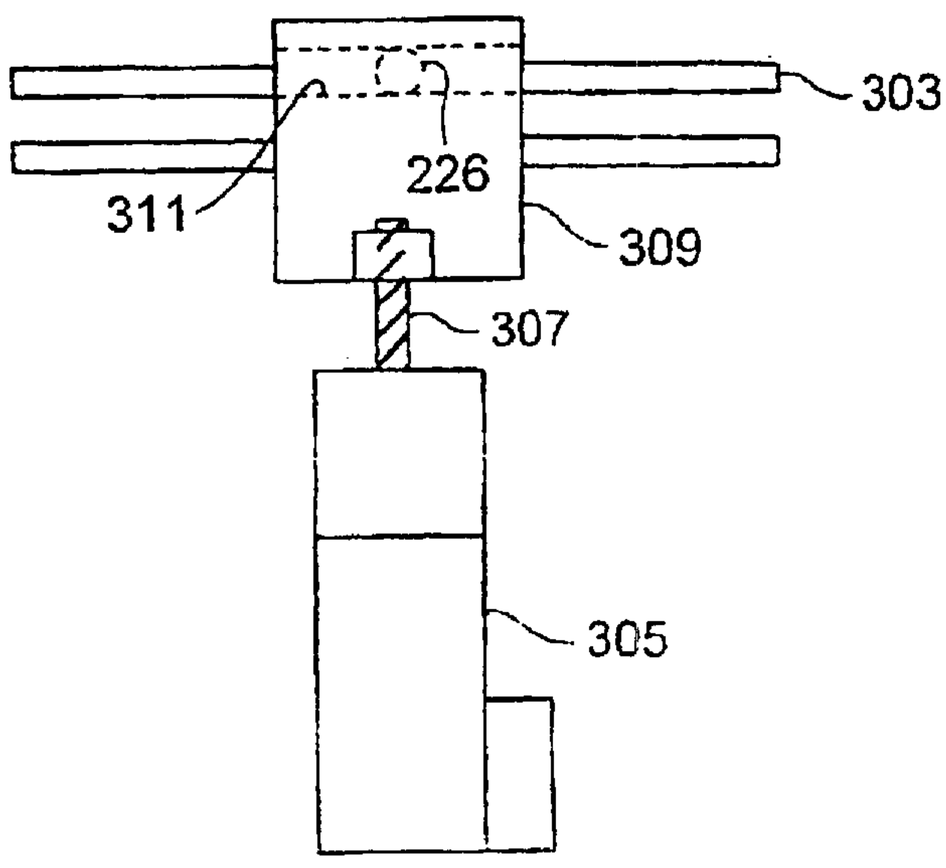


Fig.12c

Fig.13

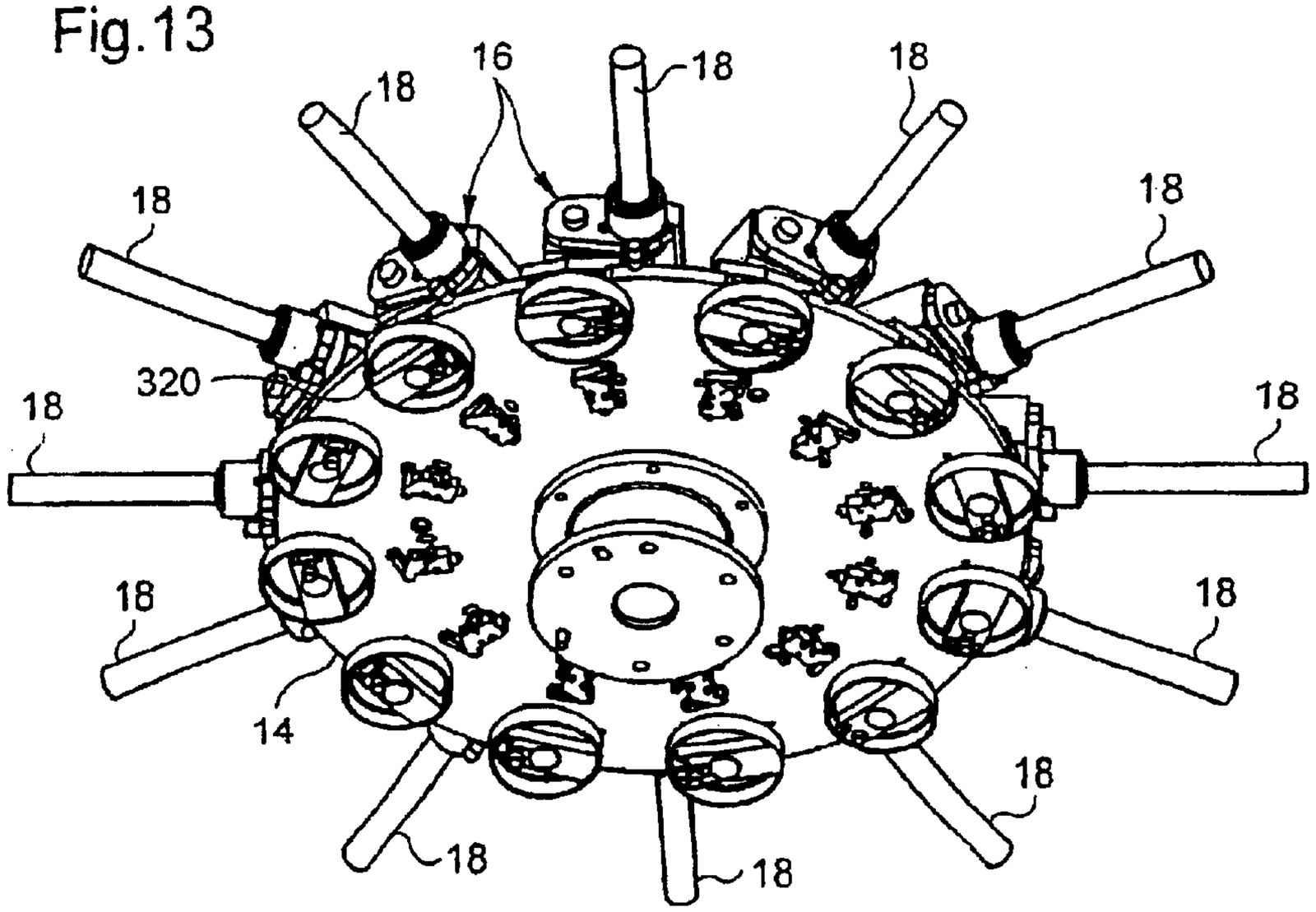


Fig.14 (A-A)

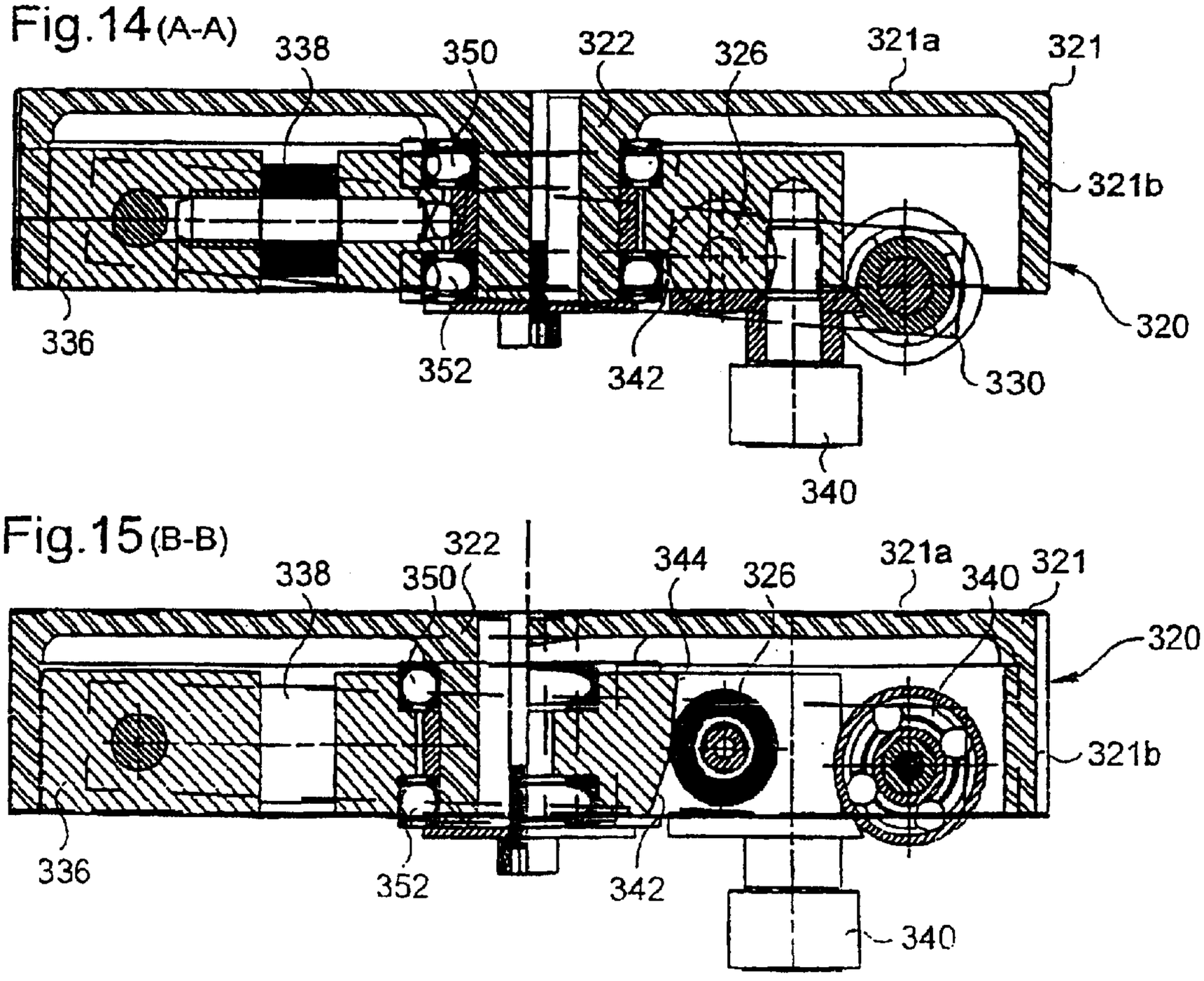
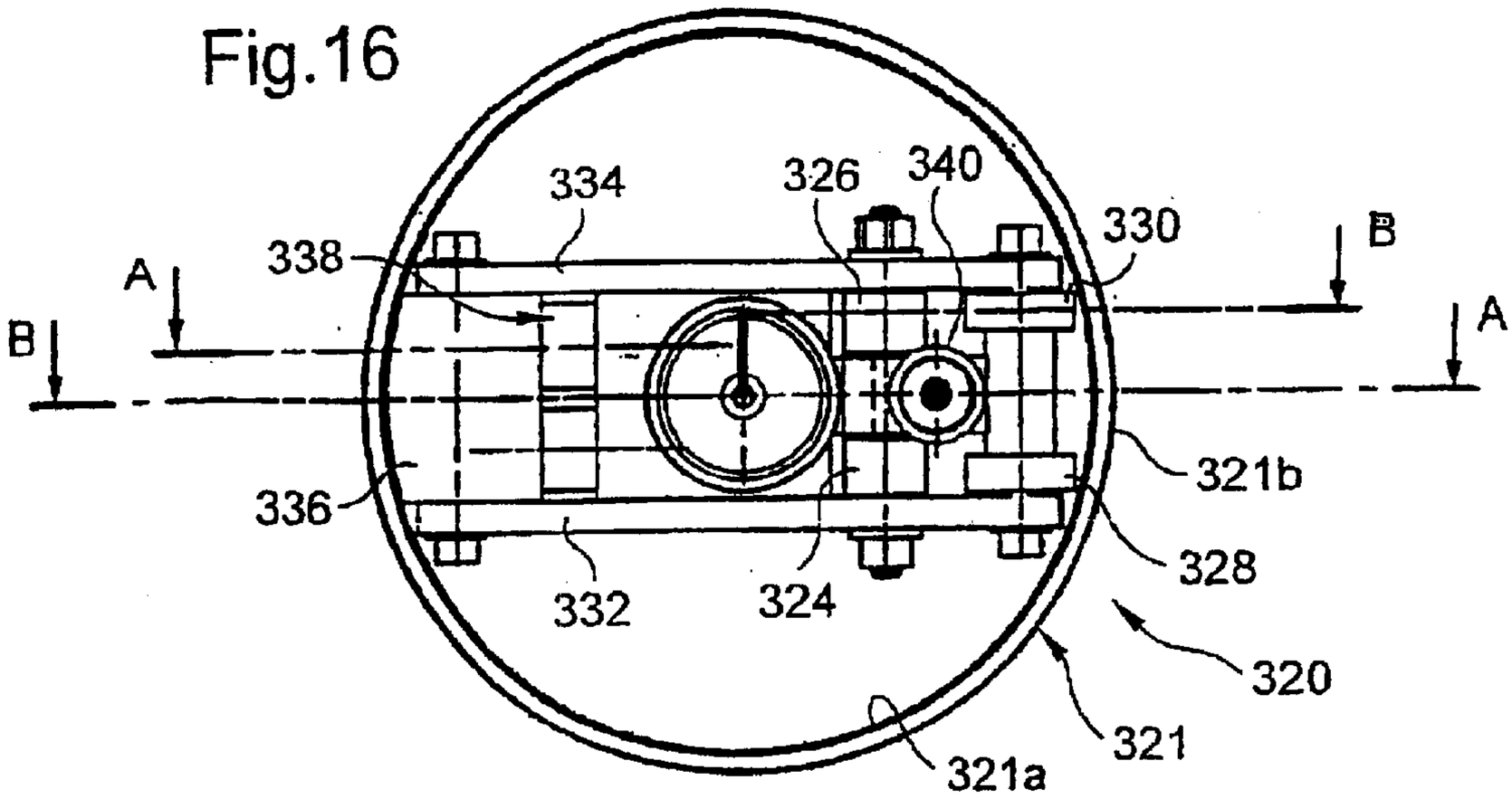


Fig.15 (B-B)

Fig.16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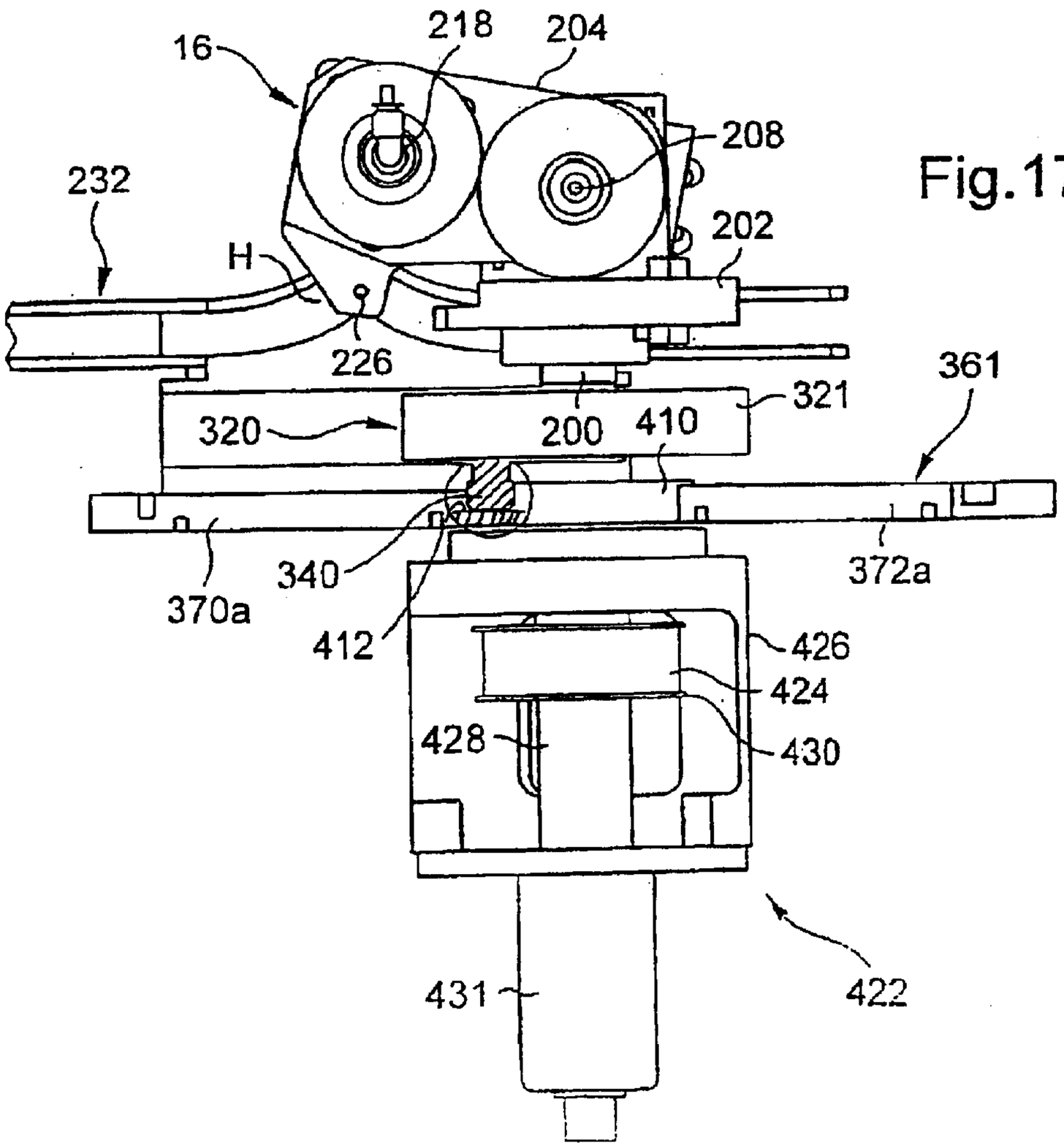
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Fig.17

Fig.18

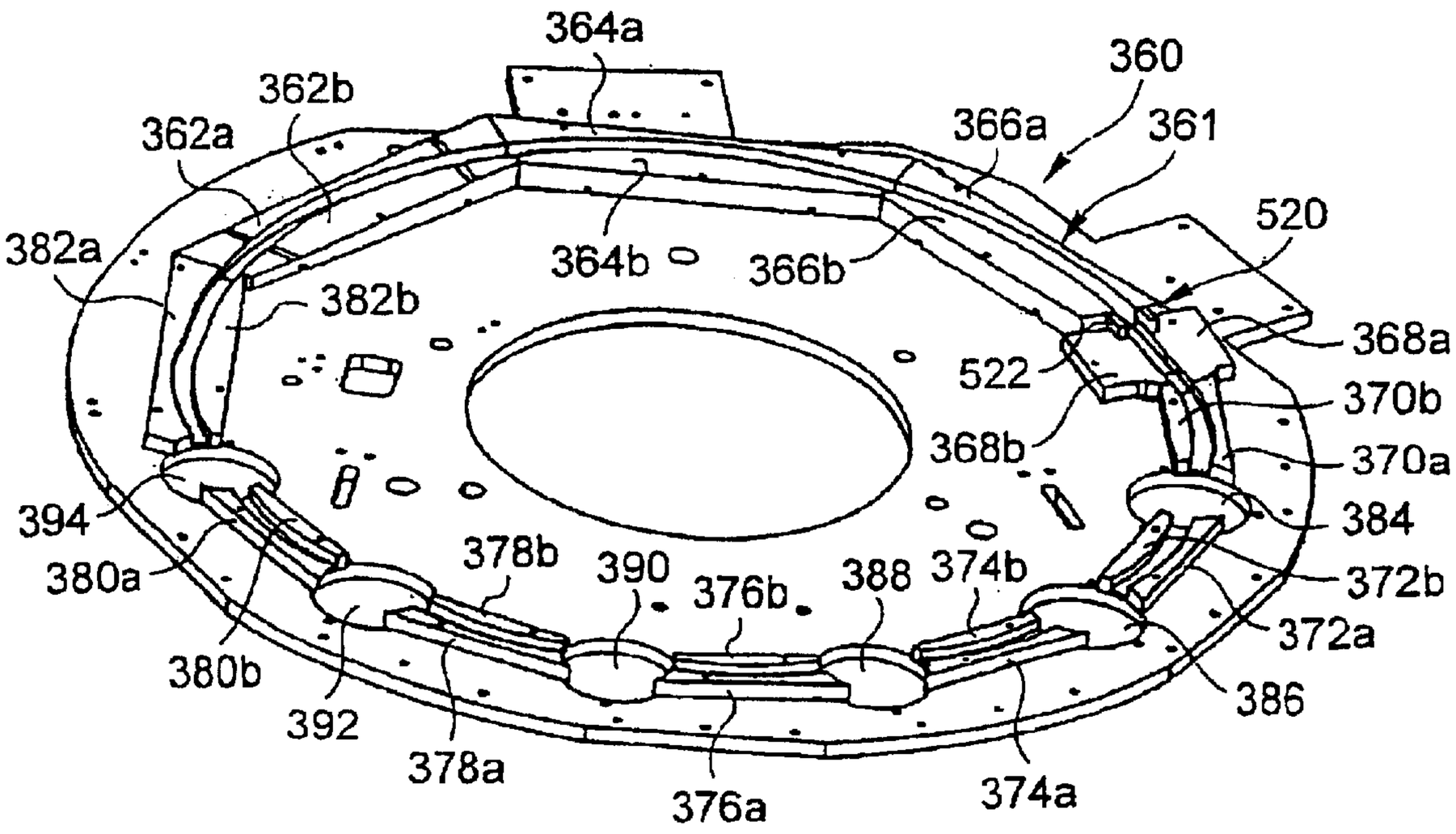
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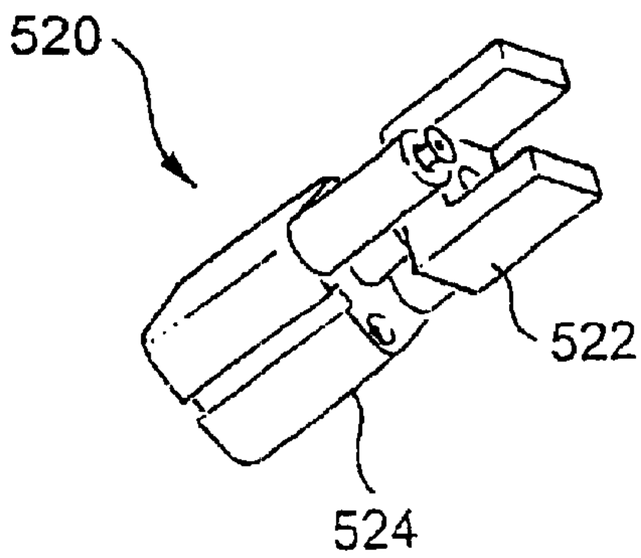
Fig.24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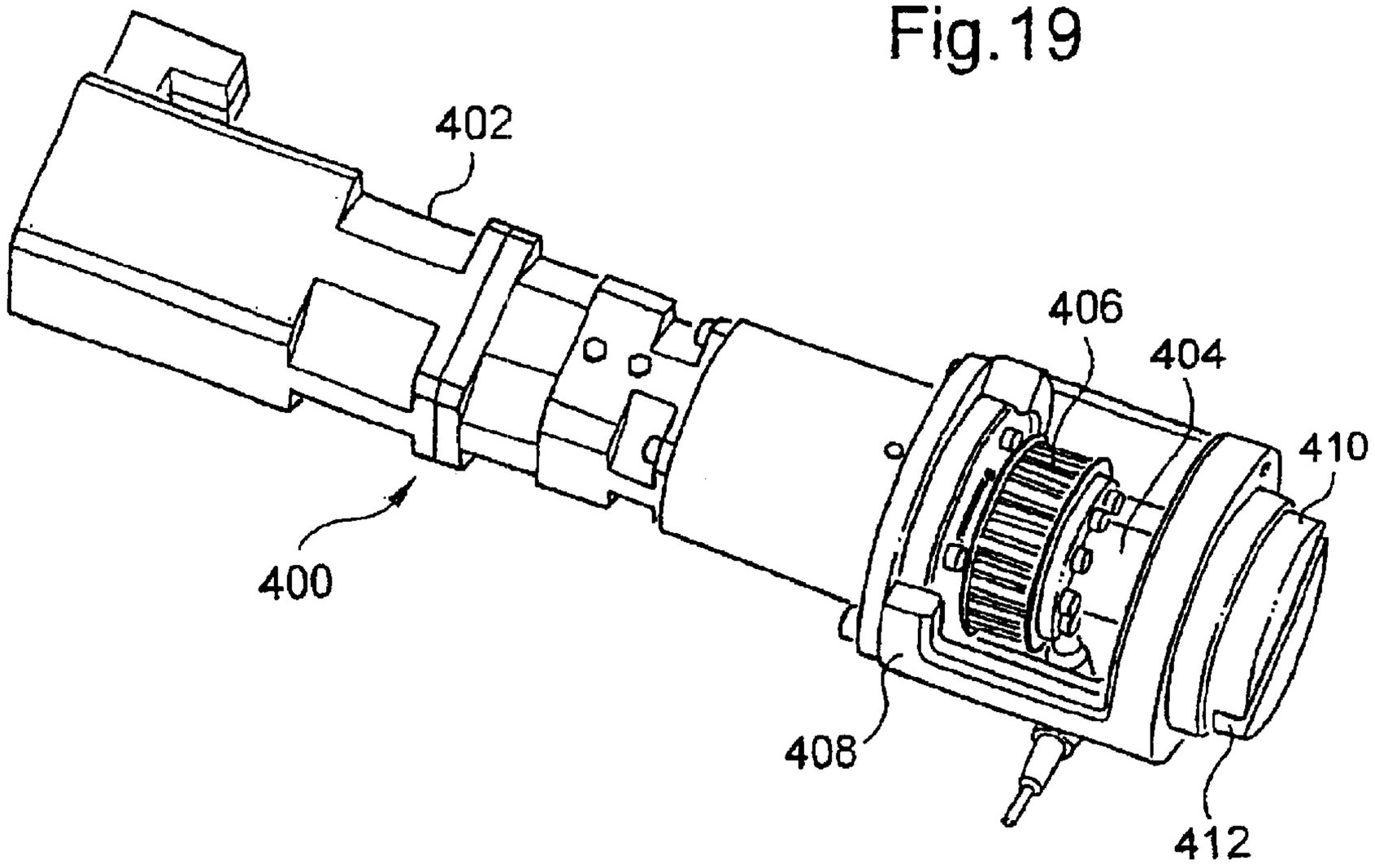
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Fig.20

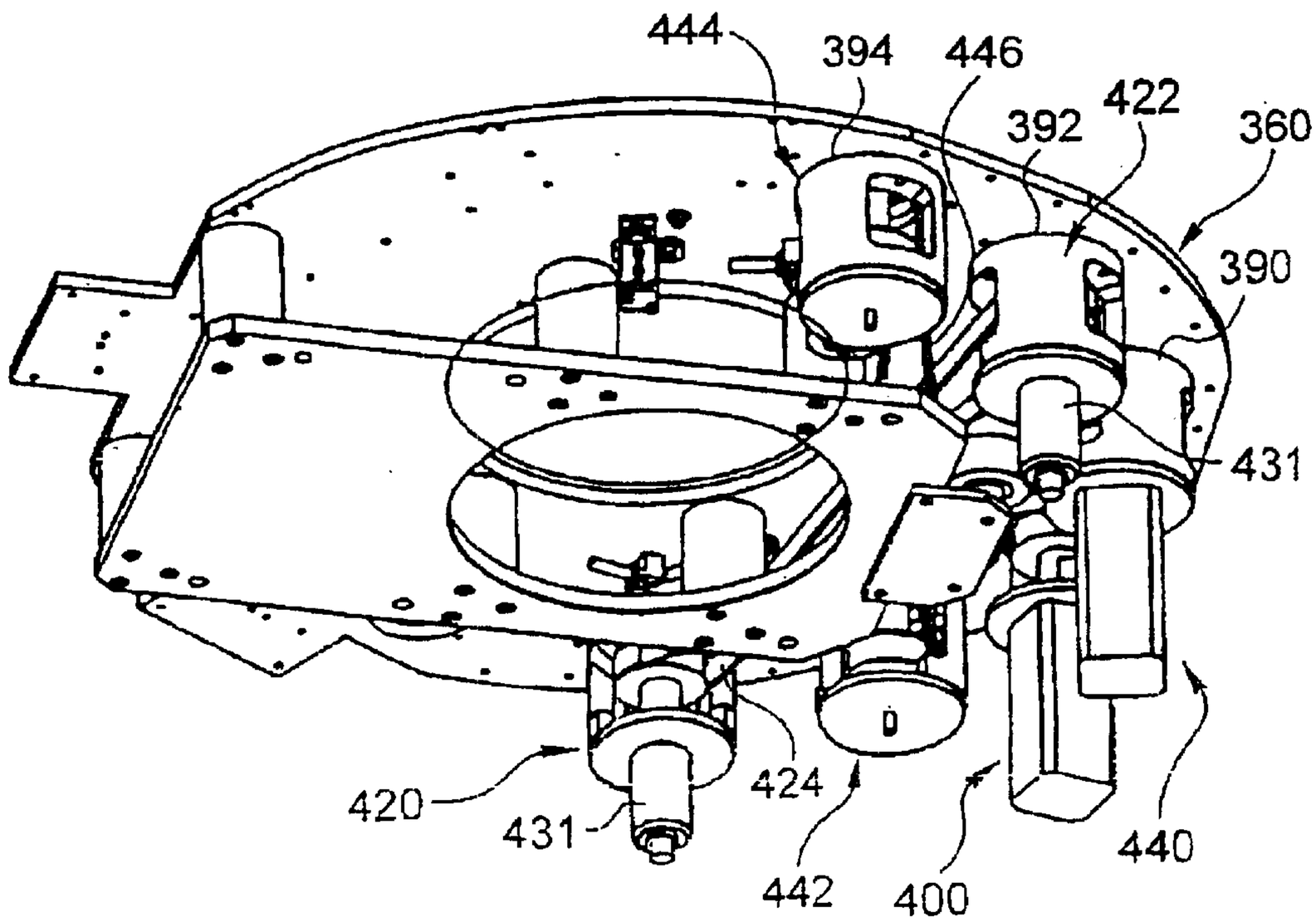
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Fig.21a

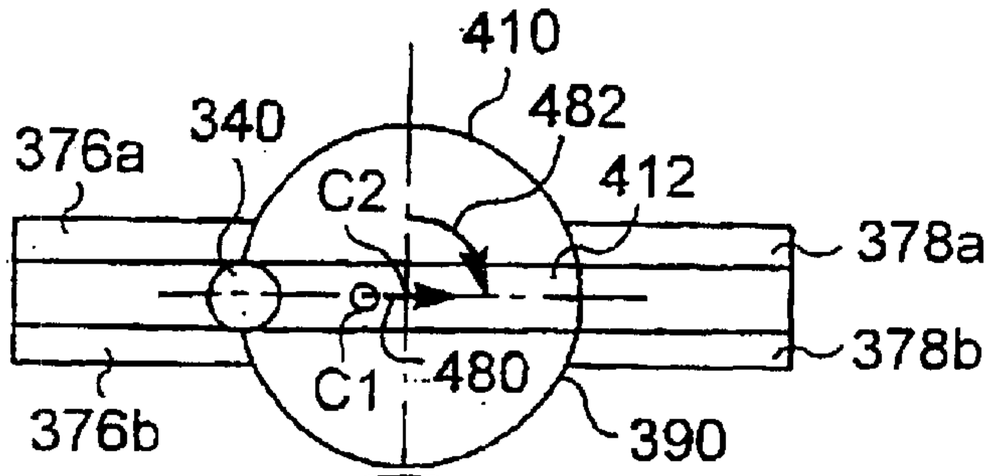


Fig.21b

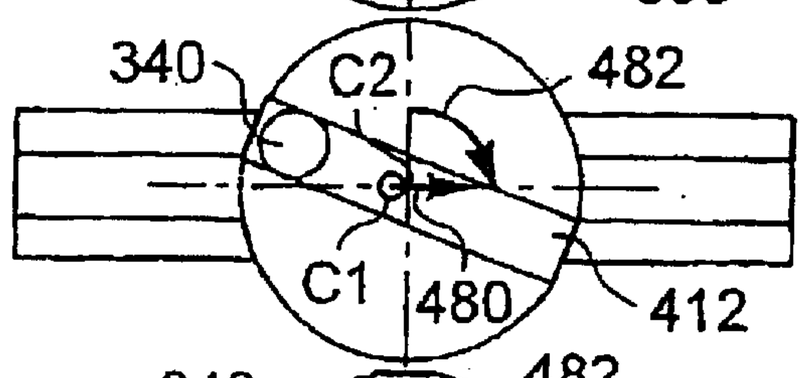


Fig.21c

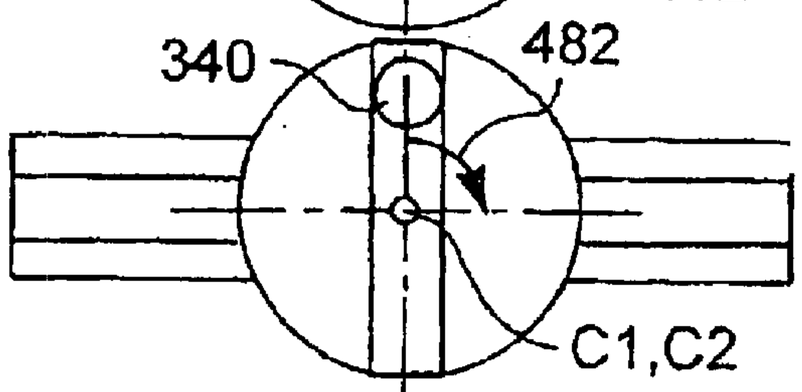


Fig.21d

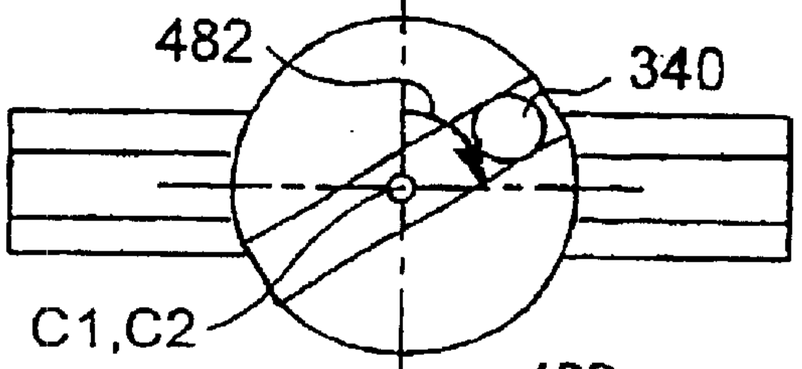
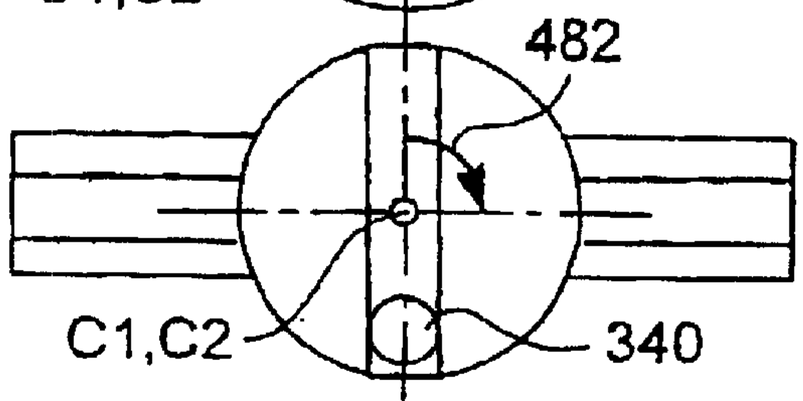


Fig.21e



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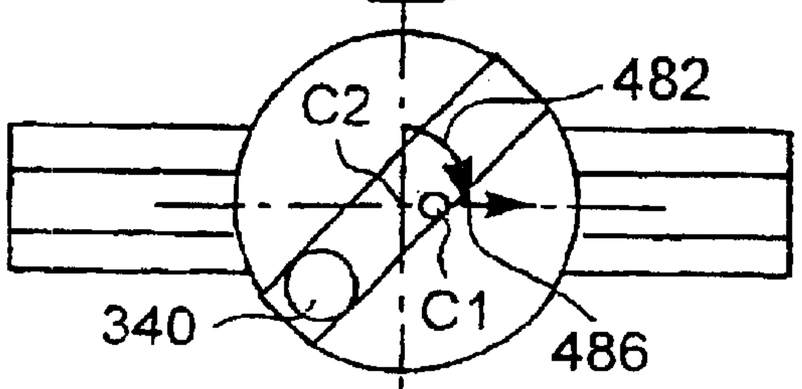


Fig.21g

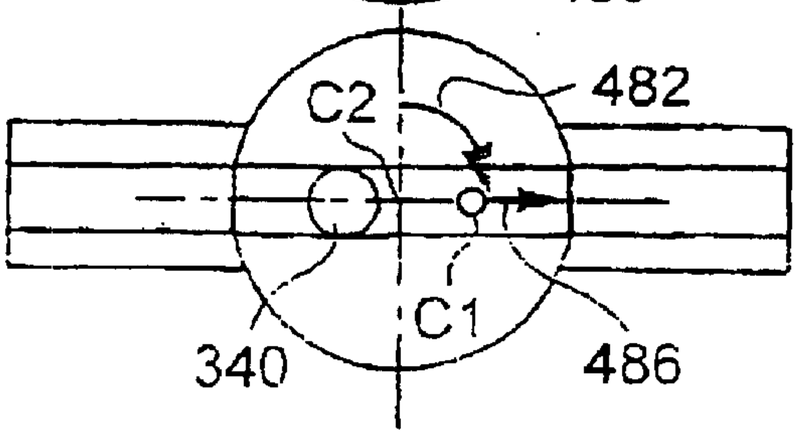


Fig.22a

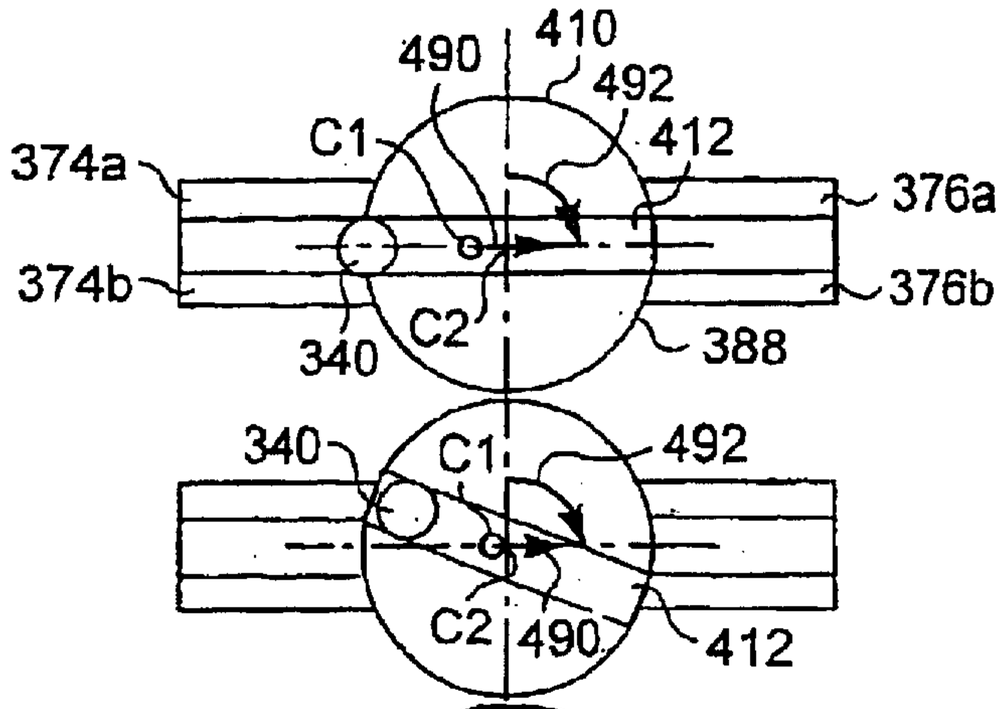
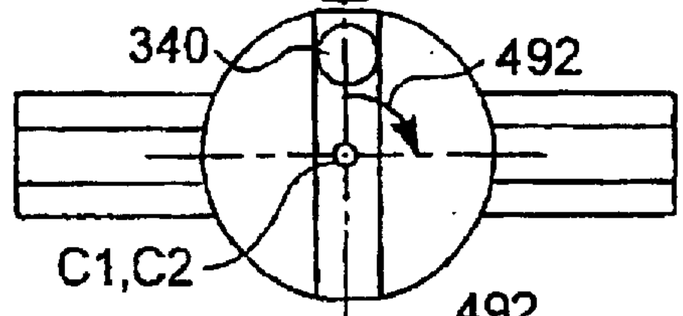


Fig.22b

Fig.22c



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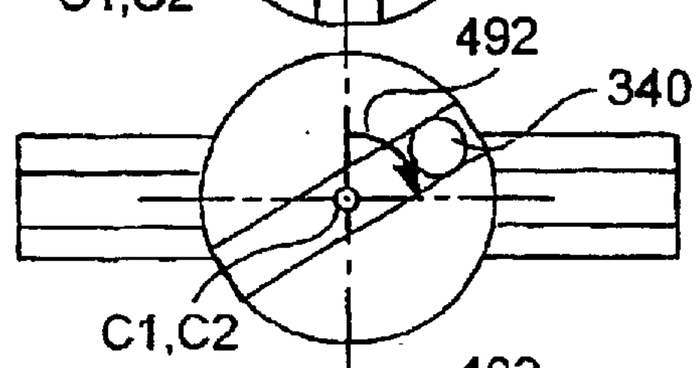


Fig.22e

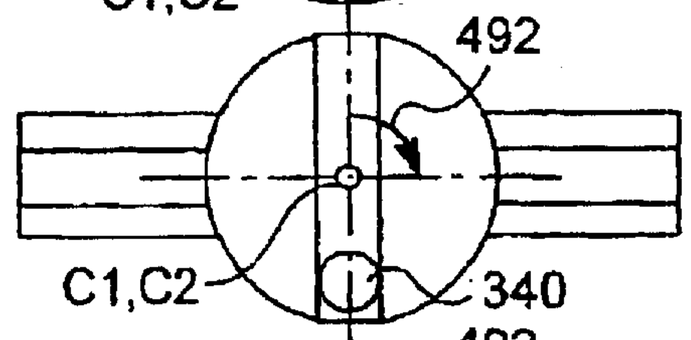


Fig.22f

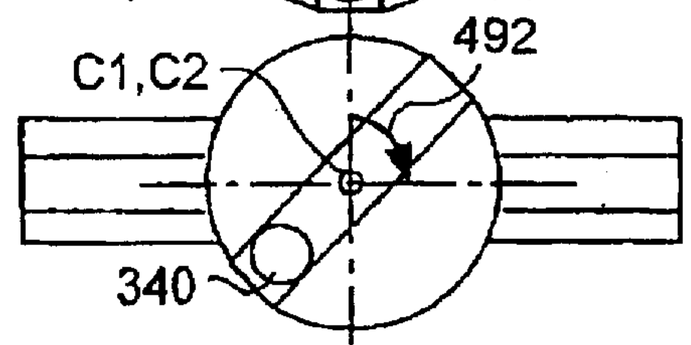


Fig.22g

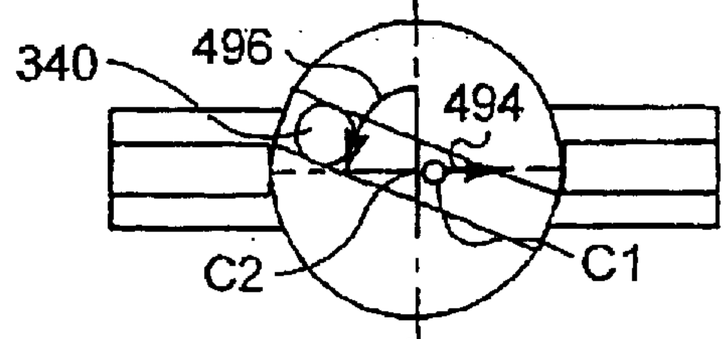
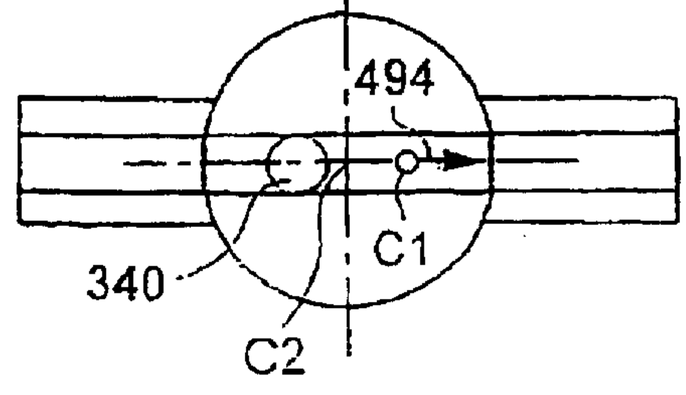


Fig.22h



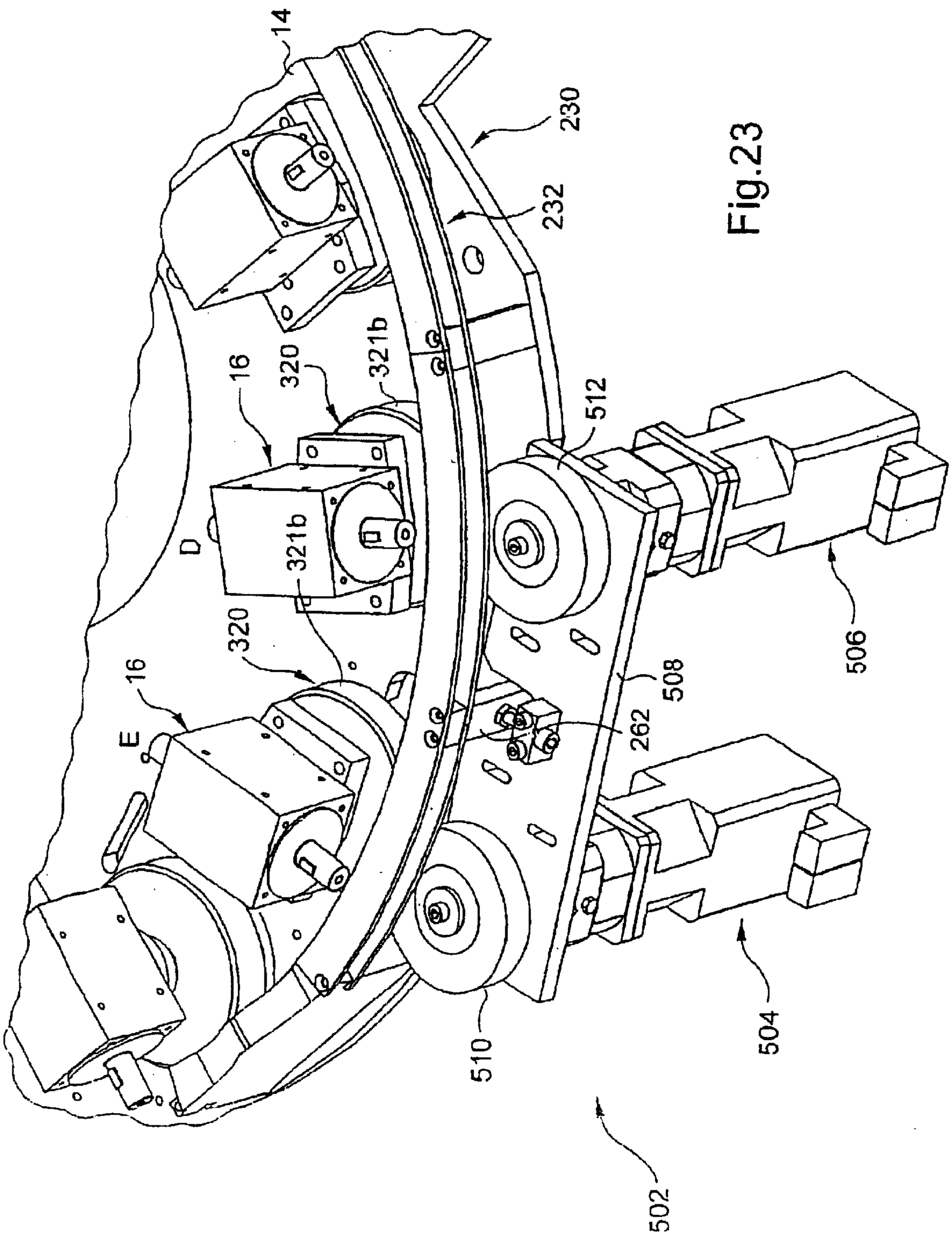


Fig.23

MACHINE FOR PRINTING ON ARTICLES

The present invention relates to a machine for printing on industrial articles such as bottles, flasks, various receptacles, and other articles of various shapes and types, such as, for example, plastics tubes.

Such machines are known which use ink to print decoration on articles.

As taught, for example, by document FR 2 782 292, filed by the Applicant, such machines comprise, for example, an indexed turntable having article-carrier devices fixed in position thereon, each device carrying an article that is to receive printing.

Each article-carrier device is provided with an outlet shaft on which the article is mounted, which outlet shaft is arranged radially relative to the axis of rotation of the turntable.

When the turntable turns in indexed manner, each article-carrier provided with its article that is to receive printing occupies a plurality of angular positions in succession, each corresponding to a station for applying a particular printing treatment to the article: flame-cleaning, dedusting, pre-registry, registry, printing, and drying.

In that type of machine, when the turntable is moved in indexed manner and an article-carrier moves from one indexed angular position corresponding to a given treatment station (e.g.: print station) to another indexed angular position corresponding to the following treatment station (e.g.: dryer station), the mandrel carrying the article and that is mounted to turn in the article-carrier being prevented from turning between successive indexed angular positions by a guide path.

Once the turntable has stopped and the article-carrier is in the desired station, a stationary actuator which is arranged at the periphery of the turntable and whose drive axis is radial and in alignment with the outlet shaft of the article-carrier turns said outlet shaft about its own axis, and thus also turns the article in order to perform a printing operation.

It is only once the turning movement delivered by the actuator has come to an end that the turntable can move again in indexed manner to bring the article to the following station, which, in the example under consideration, corresponds to a station for drying the article.

The above occurs in the same manner for each color in the print stations and the following dryer stations.

During printing, the article turns through a number of revolutions that is not necessarily an integer.

As a result, when the operation has terminated, it is not always possible for the turntable to start at once, since following a non-integer number of revolutions, the guide finger on the mandrel mounted in the article-carrier is no longer in alignment with the guide path.

It is therefore necessary, starting from such a position, to use the actuator to cause the article to turn further while the turntable remains stationary in order to achieve such alignment, which will then make it possible to restart movement of the turntable.

Although the efficiency of the printer machine briefly described above is satisfactory, the Applicant has sought to improve the throughput of a machine for printing on articles.

The present invention thus provides a printer machine for printing on articles comprising a plurality of article-carriers which are suitable for moving in indexed manner in at least one plane and following a circular path, each article-carrier being stationary in an indexed position and mobile between indexed positions, and a plurality of stations, in particular for printing, distributed around the path opposite to indexed

positions of the article-carriers, the machine being characterized in that each article-carrier is fitted firstly with an inlet shaft suitable for being turned about its own axis, in temporary and local manner by drive means each provided with a drive shaft, and secondly at least one outlet shaft for carrying an article and suitable for turning when said inlet shaft is driven in rotation about its axis, said inlet shaft and each article-carrier being suitable for being turned about its own axis by said drive shafts in register with the indexed positions, said inlet shaft being suitable for retaining the same angular orientation between print stations, the drive shaft of the drive means and said inlet shaft of each corresponding article-carrier being mutually parallel and disposed perpendicularly to the travel plane of the article-carrier.

Thus, the drive shaft and the inlet shaft of each article-carrier are constantly parallel to each other, regardless of the angular position of the article-carrier in the displacement plane.

Because of this arrangement, these two parallel shafts can be moved apart or towards each other, which movement is obtained by causing the article-carriers to move along their circular path, with these shafts simultaneously transmitting (in background time) turning movement to the article about its own axis, but without any risk of blocking the operating mechanism of the machine and/or damaging its component elements.

Because of the way the printer machine of the invention is arranged, it is therefore possible to save time during operation thereof since there is no longer any need to be completely indexed in order to be able to turn the articles.

The operating throughput of the machine is thus increased compared with the throughputs of prior art printer machines.

This advantage could not be obtained in the past with the above-mentioned prior art machine.

If the turntable supporting the article-carriers were to be made to turn simultaneously with one of the articles turning about its own axis, then the guide finger of the mandrel mounted in the article-carrier in question would no longer be in alignment with the guide path, so the drive shaft of the actuator and the outlet shaft of the article-carrier would no longer be in alignment, nor would they be parallel, and the turning movement of the turntable would be impeded.

It should be observed that if the machine includes stations for drying printed articles, such stations are interposed between the print stations so that a dryer station is disposed between two consecutive print stations.

According to a characteristic, the inlet shaft of each article-carrier is also suitable for being turned by the drive means when the article-carrier in question is moving through one or more predetermined zones of the circular path.

In certain predetermined zones of the circular path which correspond to given angular positions or to given ranges of angular positions, simultaneous and independent displacement of the article-carriers and of the articles is allowed.

The use of this background time turns out to be advantageous, in is particular when the predetermined zone (s) correspond to zones situated close to the indexed positions opposite to print stations, i.e. before and/or after an operation of printing on an article, and for several reasons.

Thus, at the end of a printing operation, it is advantageous to implement a extra print length, continuing turning movement of the article while the article-carrier restarts its movement around the circular path.

This can also be advantageous when the predetermined zone(s) correspond to zones situated in the vicinity of

indexed positions having stations arranged opposite thereto for drying printed articles.

The use of background time is advantageous for drying printed articles since starting the turning movement of the article early makes it possible to distribute the ultraviolet radiation around the article more uniformly than was possible in the past, thereby avoiding overexposure or underexposure.

This makes it possible to achieve savings in energy and also to use dryer ovens of radiating power that is better adapted to requirements.

In certain prior art printer machines, dryer ovens need to be overdimensioned in terms of heater power so as to compensate for stages of underexposure on certain portions of the articles to be dried.

According to a characteristic, the printer machine of the invention includes an indexed turntable on which the article-carriers are mounted, the turntable being mounted to turn about its central axis on a base.

According to a characteristic, the drive shaft of the drive means is stationary relative to the base.

The drive means can be provided without it being necessary for them to move with the article-carriers, and this is advantageous insofar as the weight of the moving parts including the article-carriers is therefore not increased by the weight of the drive means.

Nevertheless, provision could be made for the drive shafts not to be stationary.

According to a characteristic, the machine includes means for causing the turntable to turn, which means are different from the means for turning the inlet shafts of the article-carriers, thus enabling the two movements to be decoupled.

According to a characteristic, the printer machine of the invention includes a guide element connected to the inlet shaft of the article-carrier and suitable for moving along a guide path which is concentric relative to the circular path of said article-carrier.

According to a characteristic, the guide path comprises a succession of path portions locally interrupted opposite to predetermined zones, in each of which a corresponding path portion located between two stationary path portions, is mounted to turn about an axis perpendicular to the travel plane of the article-carriers such that, depending on the angular orientation of the moving path portion relative to the stationary path portions, the guide element is free or not free to move from a stationary path portion to the moving path portion, or vice versa.

According to a characteristic, each moving path portion is arranged in centered manner on the drive axis of the drive shaft of the drive means.

According to a characteristic, the guide element is suitable for being turned by the drive shaft of the drive means and is suitable for transmitting this turning movement to the inlet shaft of an article-carrier while the article-carrier in question is moving through one or more predetermined zones of the circular path.

According to a characteristic, the guide element is suitable for being turned while it is co-operating with a moving path portion.

According to a characteristic, the guide element is a roller.

According to a characteristic, the roller moves inside a slot in the moving path portion, the path followed by said roller being shorter than the dimensions of the slot.

According to a characteristic, the printer machine of the invention comprises, for each article-carrier, a clutch mechanism disposed between the inlet shaft of the article-carrier and the drive shaft of the means for driving said article-carrier, which clutch mechanism, depending on the clutched or declutched position it adopts, serves to allow the article to be driven in rotation either via the guide element or by some other means.

According to a characteristic, the clutch mechanism comprises at least two rollers and changeover from a clutched position of said clutch mechanism to a declutched position is triggered depending on the position of said at least two rollers along an axis perpendicular to the travel plane of the article-carriers.

According to a characteristic, the drive means of at least a plurality of article-carriers comprise at least a stationary actuator suitable for transmitting turning movement to the respective drive shafts which are suitable for turning the inlet shafts of said article-carriers.

According to a characteristic, the actuator is a brushless motor.

According to a characteristic, the brushless motor includes a variable control circuit which is controlled by at least one incremental coder.

According to a characteristic, the incremental coder determines the phase of the movements of the article-carrier drive means with great accuracy relative to the phase of the indexed rotary turntable on which said article-carriers are mounted, by means of an absolute coder secured to the slow shaft of the gearbox of the means for indexing said turntable.

According to a characteristic, the printer machine of the invention includes a plurality of stations for drying printed articles, which stations are arranged on the article-carrier path, each opposite to an indexed position of an article-carrier following an indexed position that has a print station arranged opposite thereto.

According to a characteristic, a single actuator is provided to control the turning movement of articles when the corresponding article-carriers are in the indexed positions having the print stations arranged opposite thereto, a single actuator being provided to control the turning movement of the articles when the corresponding article-carriers are in the indexed positions having the dryer stations arranged opposite thereto.

The invention also provides a method of operating a printer machine for printing on articles, the machine having a plurality of article-carriers which are adapted to move in indexed manner in at least one plane and following a circular path, the printer machine having a plurality of stations, in particular of print stations, distributed around said path opposite to indexed positions of the article-carriers, the machine being characterized in that each article-carrier is fitted firstly with an inlet shaft suitable for being turned about its own axis in temporary and local manner, and secondly with at least one outlet shaft for carrying an article and suitable for turning when said inlet shaft which is perpendicular to the travel plane of the article-carriers is caused to rotate about its axis, the method comprising the following steps:

- driving the article-carriers around their plane circular path between two indexed positions away from the vicinity thereof, while the inlet shafts of each article-carrier is not being turned about its own axis;
- driving the article-carriers around their plane circular paths when they are in the vicinity of their indexed positions;
- turning the inlet shafts of the article-carriers about their own axes when they are in the vicinity of some of their indexed positions, while the article-carriers are also being driven in rotation; and

driving in rotation the inlet shafts of article-carriers about its own axe while the article-carriers are at rest in their indexed positions.

Other characteristics and advantages appear from the following description given purely by way of non-limiting example and made with reference to the accompanying drawings, in which:

FIG. **1** is a general perspective view of a machine of the invention for printing on articles, from which the upper portion has been removed for reasons of clarity (i.e. the print stations have been removed);

FIG. **2** is a plan view showing how the various elements shown in FIG. **1** are located on the frame **12** of the machine;

FIG. **3***a* is a fragmentary perspective view of the upper portion that is removed from the device as shown in FIG. **1**;

FIG. **3***b* is a perspective view from beneath of one of the print heads of FIG. **3***a;*

FIG. **4** is a detailed view of one of the pillars shown in FIG. **1**;

FIGS. **5** and **6** are views showing the angular sector that receives the print head **36** of FIG. **3***b*, respectively showing the protective sheet in a working position (FIG. **5**) and in a retracted position (FIG. **6**);

FIGS. **7** to **9** are respectively a front view, a perspective view, and a section view of the article-carrier shown in FIG. **1**;

FIG. **10** is a diagrammatic view of a stationary table incorporating a guide path for the guide element **226** of the article-carrier shown in FIGS. **7** to **9**;

FIGS. **11***a* to **11***c* show three respective possible positions for an article-carrier of the invention;

FIGS. **12***a* to **12***c* show a variant embodiment of means enabling the article-carriers to be moved vertically;

FIG. **13** is a perspective view from beneath of the turntable **14** fitted with the article-carriers **16**;

FIGS. **14** and **15** are diagrammatic views in section respectively on planes AA and BB shown in FIG. **16** and showing a clutch mechanism of an article-carrier of the invention, respectively in the clutched position and in the declutched position;

FIG. **16** is a view from beneath of the clutch mechanism shown in FIGS. **14** and **15**;

FIG. **17** is a diagrammatic view seen from the center of the turntable **14** showing an article-carrier and its drive and guide means;

FIG. **18** is a perspective view of the cam path followed by the guide element **340** of the article-carriers;

FIG. **19** shows an actuator for turning an article-carrier;

FIG. **20** is a perspective view from beneath of the cam path shown in FIG. **18** and relative to which the various drive means are arranged;

FIGS. **21***a* to **21***g* show respectively the successive positions of the guide element **340** of an article-carrier while it is co-operating with a moving path portion **410** in register with a drying station;

FIGS. **22***a* to **22***h* show respectively the successive positions of the guide element **340** of an article-carrier while it is co-operating with a moving path portion **410** opposite to a print station;

FIG. **23** is a fragmentary diagrammatic view on a larger scale showing a portion of the FIG. **1** turntable **14** at the pre-registry station and at the registry station; and

FIG. **24** is a perspective view of a clutch member of the clutch mechanism **320** shown in FIGS. **14** to **16**.

As shown in FIG. **1** and given overall reference **10**, a machine for printing on industrial articles such as bottles, comprises a fixed frame **12** constituting the base of the machine and supporting a turntable **14** having a plurality of article-carriers **16**, each fitted with a mandrel **18** for receiving the article for printing.

In FIG. **1**, articles are not shown engaged on the mandrels for reasons of clarity.

It should be observed that other mounting equipments could alternatively be provided, such as, for example, a socket-and-spike system.

FIG. **1** shows twelve article-carriers by way of example, it being understood that this number can vary from one machine to another.

The various article-carriers are fixed in conventional manner to the periphery of the turntable **14**, with the mandrels **18** mounted on the outlet shafts of the article-carriers being arranged radially relative to the axis of rotation (Oz) of the turntable and projecting from the periphery of said turntable.

The turntable is caused to turn in indexed manner, i.e. stepwise, by means of an indexing unit shown in FIG. **2**.

The indexing unit comprises in conventional manner an indexer **20** associated with a motor and gearbox unit **22** disposed beside the indexer.

The main motor driving the indexer **20** possesses internally an incremental coder **21** having 5000 points per revolution, and on the outlet shaft of the gearbox, there is arranged an absolute coder **23** which provides information about the angular position of the "slow" shaft coming from the motor and gearbox unit **22**, in the form of 360 angular positions.

The absolute coder provides an origin point or O point for the machine, i.e. the point from which the indexer starts its rotation.

On initial startup, an origin is defined so as to initialize the counting of the incremental coder relative to the absolute coder.

Very accurate information is thus obtained concerning the change as a function of time in the position of the slow shaft, and consequently in the position of the turntable **14** at the outlet of the indexer.

This information is forwarded to each variable control circuit driving the actuators (motors) whose cycles are associated with the cycle of the indexer, e.g. for causing articles to turn under the print heads and over the drying ovens.

The angular position of each motor implementing the various transmissions is defined as a function of the number of points counted by the incremental coder.

Starting from the above-mentioned point of origin, the variable controllers of the various actuators of the article-carrier inlet shafts are incremented by a number of points equivalent to one revolution of the outlet shaft of the gearbox.

For a gearbox providing a reduction ratio of 1/20, that amounts to incrementing by 100,000 points, and for each given point, there is a corresponding position of the actuator in a table.

It is thus possible to obtain extremely accurate relative phase control between the variable control circuit controlling the motor of the actuator and the movement of the indexed turntable.

FIG. **3***a* shows the portion forming the upper framework of the printer machine of the invention which is normally arranged over the turntable **14** and the article-carriers **16**.

The upper framework **30** has three print stations **32, 34, 36** (print heads) disposed side by side in a common plane that is different from the plane of the article-carriers.

As shown in FIG. **1**, the printer machine of the invention also has three dryer stations **38**, **40**, **42** which are arranged

in a common plane that is situated beneath the plane in which the article-carriers are located.

These three stations constitute the lower framework of the machine.

In this embodiment, the machine has three print stations and three dryer stations that are offset relative to the travel plane of the article-carriers, however its architecture may be adapted to configurations having two print stations and two dryer stations, or possibly a higher number of stations.

The print machine also comprises four vertical support pillars **44**, **46**, **48**, and **50** fixed to the frame **12** in positions where they stand around the turntable **14** and the article-carriers **16**.

It should be observed that the number of pillars could be greater, depending on the number of print stations and dryer stations and on the architecture of the machine.

Each vertical pillar, such as the pillar shown in FIG. **4**, comprises a vertical column **52** having two carriages slidably mounted thereon, one of them being a top carriage **54** connected to one of the radial cross-members **56**, **58**, **60**, **62** of the upper framework **30** of FIG. **3***a*, for example, the cross-member **58**.

A second carriage **64** is also slidably mounted on the column **52** that constitutes a slideway, this carriage being secured to one of the dryer stations **38**, **40**, **42**, and more particularly to an ultraviolet (UV) radiation dryer oven such as the oven **38** of FIG. **1**, for example.

Each carriage **54**, **64** is also mounted on a screw **66** with oppositely-handed threads extending parallel to the column **52**.

As shown in FIG. **4**, the two opposite ends of the column **52** and the screw **66** with oppositely-handed threads are held in place in respective top and bottom boxes **68** and **70** which are permanently secured to the machine.

The bottom end of the screw **66** projects from the box **70** and is engaged inside a pulley wheel **72** which, when turned, serves to rotate the screw with oppositely-handed threads.

As shown in FIG. **2**, a motor and gearbox unit **74** drives a cog belt **76** whose path, shown in plan view in this figure, is determined so as to pass via the various driving pulley wheels **72**, **78**, **80**, and **82** of the corresponding screw with oppositely-handed threads which are arranged inside respective pillars **46**, **44**, **48**, and **50**.

A belt path as shown is obtained by mounting the belt **76** around two deflector wheels **84**, **86** arranged on a plate **88** on which the motor and gearbox unit **74** is mounted and around four deflector wheels **90**, **92**, **94**, and **96** that are fixed to a plate **98**.

Thus, the motor and gearbox unit **74** drives the belt **76** which meshes with the pulley wheels **72**, **78**, **80**, and **82**, thus acting symmetrically, depending on the direction of rotation of the motor, to cause the carriages **54** and **64** and the pillars **44**, **46**, **48**, and **50** to move towards each other or apart from each other, thereby moving the print heads and the dryer ovens that are fixed respectively to said carriages towards each other and apart from each other.

The respective up and down movements of the lower framework (dryer stations) and of the upper framework (print heads) which are offset relative to the turntable, are controlled as a function of operating requirements (adjusting the spacing between the stations as a function of the dimensions of the articles), or for machine maintenance.

A position sensor **100** mounted on a rod which is itself arranged on a bar fixed to the carriage **64** provides information concerning the vertical positions of the carriages carrying the dryer ovens, thus making it possible to control in three dimensions the opening and closing of the lower and upper frameworks of the machine.

Thus, simultaneous vertical adjustment of the print heads and of the dryer ovens makes it possible to adapt the machine to articles of various shapes and sizes.

The machine is therefore not restricted in its operation by the articles for printing being of dimensions that are too large.

Furthermore, for maintenance operations such as, for example, changing the indexer **20**, it is advantageous to be able to move the lower and upper frameworks apart from each other.

In addition, and as explained below, the ability of the print heads to move vertically is advantageous for obtaining access to the print screen in order clean it, or indeed replace it.

Furthermore, this offset configuration for the print heads and the dryer stations makes it possible to increase considerably the print length of the print screens relative to a prior art machine, the travel of the print screens then being limited by the thermal protection elements placed on either side of the articles.

It should also be observed that the above-described arrangement is also advantageous even when only the print stations are offset or when the printer machine in question has print heads only and no dryer ovens.

A print head of a print station mounted on the upper framework **30** of the printer machine of the invention is described below with reference to FIGS. **3***a*, **3***b*, **5**, and **6**.

As shown in FIG. **3***a*, the print heads **32**, **34**, and **36** are arranged in spaces defined between two consecutive radial cross-members amongst the cross-members **56**, **58**, **60**, and **62**, and more particularly the angular spaces or sectors provided are made in the form of cutouts in respective pieces of sheet metal **110**, **112**, and **114**.

There follows a description of the structure of the print head **36** which is identical to that of the other heads **32** and **34**.

The print head **36** comprises a two-part frame **120** in which the top part **122** is fixed to the cut-out sheet **144** by conventional means, while the bottom part **124** serves as a support for a motor **126**, an assembly **128** sliding on a radial slideway **130** and carrying an assembly **132** comprising a doctor blade and a doctor blade support, together with a print screen **134**.

The assembly **128** also comprises an cylinder actuator **136** for controlling vertical down or up movement of the doctor blade and an actuator **138** for controlling vertical up or down movement of the doctor blade support.

Two adjustment buttons **140** and **142** are also provided, respectively for the doctor blade and the doctor blade support.

An actuator **144** is provided for lifting the doctor blade/doctor blade support assembly and it is connected to a block **146** secured to a shoe **148** suitable for sliding on the slideway **150** mounted vertically on a framework-forming structure **152** which is fixed to the bottom frame **124**.

Movement of the screen in translation in the direction shown by the double-headed arrow referenced D in FIG. **3***a* is provided by a rack-and-pinion assembly **154** which is driven by the motor **126**, as can be seen in FIG. **3***b* which is a perspective view of the print head as seen from beneath.

Two adjustment buttons **156** and **158** are provided respectively on the front portion of the print head **36** in order to make it possible to turn the print screen in the x, y plane and perform depth adjustment, i.e. to adjust the screen radially relative to the axis of rotation of the turntable **14**.

As shown in FIG. **3***a*, a plurality of protection elements forming a thermal protection screen, in particular protective

metal sheets, are arranged in the bottom portion of the framework **30** beneath the print head **36** so as to protect the print head from the ultraviolet radiation emitted by the dryer ovens which are disposed beneath the radial cross-members **60** and **62**.

The protective elements for each print head are more particularly defined by two stationary protective sheets **162** and **164** having a hinged protective sheet **166** arranged between them capable of moving between a working position shown in FIG. **5** and a retracted position shown in FIG. **6**, which position is used when maintenance work needs to be performed on the print head, such as replacing the print screen.

Two cylinders actuators **168** and **170** are fixed via one end, each to two respective angle brackets (not shown) which are secured to the radial cross-members **60**, **62**, and via respective opposite ends to the moving protective sheet **166** which is hinged about a hinge that is not visible but which has fastening screws **172**, **174**, **176**, **178** that can be seen in FIG. **6**.

During maintenance work that requires the sheet **166** to be retracted, the print heads are moved away from the turntable **14** through a distance that is greater than that defined for normal operation of the machine so as to leave a space of sufficient size beneath the print station to allow the sheet **166** to pivot as shown in FIG. **6**.

It should be observed that there is a slot or opening **180** formed in the protective sheet **166** in order to enable the article for printing to be inserted in part through said slot in order to receive printing via the print screen **134** shown in FIGS. **3***a* and **3***b*.

The structure and the operation of the article-carriers **16** as carried by the turntable **14** shown in FIG. **1** are described below with reference to FIGS. **7** to **10**.

FIG. **7** shows one of these article-carriers **16** comprising an inlet shaft **200** driven by drive means that are described below.

The article-carrier **16** has a base **202** for securing to the by turntable **14** of FIG. **1**, and on which there is mounted a moving portion **204** which, as explained below, can move away from the travel plane of the article-carriers and can move into a plurality of positions that are spaced apart along a vertical axis (z axis) which is perpendicular to the plane of the turntable **14**.

The article-carrier **16** has an angle-changing gearbox **206** which receives as its inlet the inlet shaft **200** passing through the base **202** and transforms the turning movements of this vertical shaft to turn a horizontal shaft **208** that passes through the gearbox **206** (FIGS. **8** and **9**).

The moving portion **204** of the article-carrier **16** is constituted by two side plates **210**, **212** on either side of the gearbox **206** and which are mounted to pivot about the shaft **208** by ball bearings **216**.

The end **224** of the rotary outlet shaft **218** opposite from the end carrying the gearwheel **222** is adapted to receive a mandrel **18** as shown in FIG. **1** and is turned by the shaft **208** via a gearwheel **220** secured thereto and meshing with the gearwheel **222** secured to the shaft **218**.

Thus, the turning movement transmitted to the inlet shaft **200**, which is said to be driven shaft, is subsequently transmitted by the above-described mechanism to the axis **208**, and via the gearwheels **220** and **222**, this movement is transmitted to the outlet shaft **218**, thereby turning the article for printing that is mounted on the mandrel **18**.

The article-carrier **16** also includes, in the bottom portion of the body of the moving portion **204**, a guide element or wheel **226** of axis parallel to the axes of the shafts **208** and **218**, for co-operating with a cam path that is shown in FIG. **10**.

FIG. **10** shows a stationary table **230** secured to the frame **12** of the printer machine of the invention and including a cam path **232** within which the respective wheels **226** of the various article-carriers **16** shown in FIG. **1**.

More particularly, this cam path, which is of generally circular shape, is formed by two parallel tracks constituted by a plurality of plates and wall elements that are curved or straight depending on location, disposed one after another around each track, the plates and wall elements of the two tracks being arranged parallel to one another and leaving between them a gap for passing the guide elements **226**.

These two tracks comprise a portion **233** which corresponds to about half of the circular cam path and in which the mutually parallel plates are plane, thus keeping the guide elements **226** in plane path portions at a common vertical position along an axis perpendicular to the plane of the turntable **14**.

This intermediate or neutral position is represented by the letter N (neutral) in FIG. **10**.

The guide path **232** also comprises path portions or cams **234**, **236**, **238** in which the corresponding parallel wall elements and plates are curved upwards so as to form rising path portions (inclined ramps) for the guide element **226**, thus bringing it into a high position referenced H.

The path **232** also has path portions or cams **240**, **242**, and **244** in which the corresponding parallel wall elements and plates are curved downwards so as to constitute descending path portions (inclined ramps) for the guide element **226**, thus bringing it into a low position referenced B.

These rising and descending path portions are separated from one another by respective straight path portions **246**, **248**, **250**, **252**, and **254** which maintain the guide element **226** in the neutral or intermediate position N.

It should be observed that the upwardly-curved path portions and the downwardly-curved path portions which correspond to locally fitted cam profiles are respectively three in number, which number corresponds to the three print stations and to the three dryer stations.

The use of such curved path portions (cam profiles) and plane portions is described below with reference to FIGS. **11***a* to **11***c*.

The table **230** comprises a base **260** on which the guide path **232** is fixed by vertical uprights **262** and by vertical wall elements **264**.

The base **260** also includes six openings **266**, **268**, **270**, **272**, **274**, and **276** which are designed to receive means for turning the various inlet shafts **200** of the article-carriers **16**.

Each of these openings is designed to receive means for turning the shaft **200** of the corresponding article-carrier when it is positioned in one of the three print stations or in one of the three dryer stations, or in a predetermined zone very close to any one of them.

FIGS. **11***a* to **11***c* are three diagrammatic views showing the principle of an article-carrier **16** carrying on its outlet shaft **218** an article **300**, e.g. of cylindrical shape, in the various vertical positions, which positions have been exaggerated deliberately.

FIG. **11***a* shows the article-carrier **16** mounted on the turntable **14** with its guide element **226** placed in a straight portion of the guide path **232** of FIG. **10**, holding said guide element in an intermediate or neutral vertical position N.

The path **232** is deliberately shown in dashed lines in these figures so that the other elements can be seen more clearly, with this being particularly useful in FIG. **11***c*.

When the turntable **14** turns in the direction shown by arrow **302** in FIG. **11***a*, the guide element **226** travels along the cam path **232**.

When the guide element **226** reaches the rising portion of the path **234** (FIG. **11***b*), it follows the cam profile imposed by this path portion (inclined ramp) causing its vertical position to change, and thereby turning the moving portion **204** of the article-carrier **16** about the axis of the shaft **208**, as shown by the arrow referenced **304**, while continuing to be driven by the movement of the remaining portion of the article-carrier along the plane trajectory in the direction shown by arrow **302**.

During this movement, the outlet shaft **218** carrying the article moves transversely to its axis, going away from the plane of the turntable **14**.

This change in position of the guide element **226** brings the article into the high position in the slot **180** formed through the protective sheet **166** so as to come into contact with the print screen **134** of the corresponding print head (not shown in this figure).

When the article passes through the slot **180** formed in the protective sheet **166**, it blocks off the opening almost completely, and by means of this configuration, the ultraviolet radiation from the dryer ovens has practically no further influence on printing operations.

In addition, by locating the print heads and the dryer ovens away from the turntable, more space is made available to increase the print length of the print screens, which print length were previously limited by the presence of the thermal protection elements.

When the article-carrier is in the position shown in FIG. **11***b*, i.e. the high position, the article **300** can receive printing, which requires the article to be turned, as described below.

Nevertheless, it is particularly advantageous to observe that the article **300** begins to be turned before the guide element **226** reaches the high position H, and continues to turn after it has begun to move down the slope, with this being for reasons that are given below.

As the guide element continues to move along the cam path **232** after the printing operation has been performed, it passes along a straight portion of path **246** where it is in the intermediate or neutral position N, after which it reaches a descending portion of path **240** (FIG. **11***c*).

The downward change in the vertical position of the guide element **226** (to low position B) causes the moving portion **204** of the article-carrier **16** to pivot about the axis of the shaft **208** in the direction shown by arrow **308**, thus bringing the article **300** into the low position.

In this movement, the outlet shaft **218** carrying the article moves parallel to its axis away from the plane of the turntable **14**.

As shown in FIG. **11***c*, the article **300** becomes partially engaged in a slot **310** formed in a protective casing **312** of one of the dryer ovens **38**, **40**, **42** of FIG. **1**, with only a top wall **314** being shown in FIG. **11***c*.

The ability of the article-carrying portions of the article-carriers **16** to move vertically thus makes it possible not only to reach the print heads arranged above the turntable **14**, but also to reach the dryer ovens arranged below the turntable.

When the article passes through the slot **310** formed in the protective screen **312** it shuts off the opening almost completely, and by this arrangement the amount of ultraviolet radiation emitted from the drying ovens is very greatly reduced, which radiation might otherwise influence printing operations.

The drying operation is also better controlled since heating power is adjusted to be as close as possible to requirements, there being no need for the ovens to be overdimensioned in order to compensate for losses as in the past.

In this arrangement of the printer machine of the invention, the dryer ovens are further away than in the past from the print heads, thus making it possible firstly to leave more room for the print length of the print screens, and secondly to reduce the influence of the ultraviolet radiation emitted by the ovens on the print heads.

It should be observed that the influence on the print heads, and more particularly the consequences of interfering radiation tending to dry or to polymerize the ink on the screen, would still be reduced even if only the print heads or only the ovens were offset from the turntable carrying the article-carriers.

The ability of the article-carriers to move in a direction perpendicular to the plane of rotation of the turntable **14** presents other advantages.

It should be observed that since the guide element or roll **226** on each article-carrier is inseparable from the guide path **232**, the position of this guide element relative to the print heads or to the dryer ovens is independent of the turntable and of any defects it may have (warping, . . .).

The position of the article that is to receive printing, when it is mounted on the article-carrier, is thus relatively unaffected by the influence of any defect in the planeness of the turntable **14**.

In addition, it has been found that in prior art printer machines, while performing printing operations, non-negligible forces are exerted on the article that is to receive printing and thus on the article-carrier and the turntable.

This leads to deformation of the turntable which can be harmful to proper operation of the printer machine.

In addition, in order to avoid possible deformation of the turntable, manufacturers of printer machines have sometimes been led to overdimension the turntable in order to make it suitable for taking up such forces.

With the printer machine of the invention, the forces exerted during a printing operation on the article that is to receive printing are taken up by the guide element or roll **226** of the article-carrier, and are subsequently supported by the guide path **232** and thus by the base of the machine.

These forces are thus no longer conveyed to the turntable which therefore no longer needs to be overdimensioned.

It should also be observed that by varying the vertical position of the article-carrier, or at least of a portion thereof, and thus by varying the position of the article that is to receive printing, it is possible to adapt the printer machine to articles of different shapes and sizes.

Furthermore, other means enabling the vertical position of the article-carriers, and more particularly the portions of the article-carriers that carry articles that are to receive printing, can be used instead of and replacing the guide element **226** and the cam path **232**.

Instead of and replacing the cams **234**, **240**, **236**, **238**, **244**, and **242**, it is thus be possible, for example, to devise equipment having a cam path that is neutral all around its circular travel, but that is locally interrupted at the locations where the above-described cams are disposed in FIG. **10**. The cams can then be replaced by vertically movable assemblies, each having a groove co-operating with the neutral cam path. Such assemblies can occupy a low position or a high position, moving by means of a worms crew, for example, under the control of a brushless type motor synchronously with the movement of the article-carriers.

This variant is shown in highly diagrammatic manner in FIGS. **12***a*, **12***b*, and **12***c*, in which there can be seen the equipment **301** including the neutral cam path **303** in which the roll **226** travels.

The vertically movable assembly comprises an actuator, and more particularly a numerically-controlled motor **305**

which controls rotation of a ball screw **307** mounted at the outlet of the motor, the screw being engaged in a threaded portion in the bottom of a substantially prismatic block **309** that forms a carriage, so that turning the screw in one direction or the other causes the carriage to move up or down (displacement of the carriage in translation).

A slot **311** is formed in the top portion of the carriage **309** to receive the wheel **226** traveling along the path **303** (FIG. **12***a*) in the direction indicated by arrow **313**, when the slot **311** is arranged at the same height as the path **303**, as shown in FIG. **12***b*.

Once the wheel is held captive in the slot **311**, the motor causes the assembly to rise by turning the ball screw **307**, as shown by vertical arrow **315**, thus enabling the article-carrier and the corresponding article to be brought into a high indexed position analogous to that shown in FIG. **11***b*, and opposite to the print stations.

The movement imparted by the motor to cause the carriage **309** to rise can start from the position shown in FIG. **12***b*, once the wheel penetrates into the slot **311**.

The same applies for moving the article-carrier and the corresponding article into a low indexed position analogous to that shown in FIG. **11***c* opposite to dryer stations, by causing the carriage **309** to move downwards.

This variant is advantageous insofar as it enables practically vertical relative trajectories to be followed between the article and the protection elements **166** (print head) or **312** (oven), which is not possible when using a cam profile of the kind described above.

It is thus possible for the positioning of the article relative to the slot **180** (print head) or **310** (oven) to be adjusted even more accurately, thereby enabling the print screen to better protected from ultraviolet radiation than before.

As a result, the more accurate positioning of the article relative to the above-mentioned slot enables the size of the slot to be reduced, thereby additionally is reducing the influence of radiation on the print screens.

It would also be possible, in addition to the above-described guide system using a roll and a cam path, to devise additional means on board each article-carrier in order to obtain additional movement adapted more accurately to the shape and/or size of the article that is to receive printing, whether the article-carrier is in its high position and/or in its low position.

As shown in FIG. **13**, the various article-carriers **16** provided with their mandrels **18** which are fixed to the turntable **14** include respective clutch mechanisms **320** arranged beneath the turntable.

This mechanism is in the form of a cylindrical cup **321** having a horizontal bottom **321***a* from which there extends a vertical skirt **321***b*. The bottom portion of the cup is open as can be seen in FIG. **13** and the inlet shaft **200** of each corresponding article-carrier is mounted securely in a central hub **322** secured to the bottom **321***a* of the cup, as shown in FIGS. **14** and **15** (in these figures, the inlet shaft **200** of the article-carrier is not shown).

It will thus be understood that turning the cup **321** causes the inlet shaft **200** of each article-carrier to turn, and consequently also causes the outlet shaft **218** of the article-carrier and thus the article to turn, as described above.

The arrangement of the clutch mechanism **320** beneath the article-carrier is shown in a front view in FIG. **17**.

As shown in FIGS. **14** to **16**, the clutch mechanism **320** comprises more particularly an assembly of two rollers and two wheels mounted in pairs on two parallel shafts, one set of rolls **324**, **326** and one set of rollers **328**, **330**, each of the sets of rotary members being mounted on a shaft secured to two parallel arms **332**, **334** which are secured to a jaw **336** diametrally opposite from the two above-mentioned sets of members. In the clutched position of the mechanism, the jaw **336** comes into contact with the inside wall of the skirt **321***b* of the cup **321** under drive from springs **338**.

A guide element **340** or roller mounted to rotate about a vertical axis projects from the mechanism constituted by the rollers, wheels, arms, and jaws, this element making it possible in the clutched position of the mechanism as shown in FIG. **14** which is a view in section on plane AA of the mechanism shown in FIG. **16**, to transmit turning movement to the cup **321** which is in contact with the jaw **336**, and thus to the inlet shaft **200** of the article-carrier in question.

As explained below, this turning movement is imparted thereto by a drive shaft of a driver.

It should be observed that in the clutched position shown in FIG. **14**, the roller or guide element **340** is in a low position and the wheels **324** and **326** are in contact with a first portion **342** of a steeply-sloping ramp.

As explained below, when external means are actuated to bear against the rollers **328** and **330**, that causes the arms **332** and **334** to rise and thus causes the wheels **324** and **326** to rise, which wheels move up the sloping ramps **342** and reach a ramp **344** that slopes less steeply. This has the effect of exerting traction force on the jaw **336** via the arms **332** and **334**, compressing the springs **338**, and thus creating clearance between the inside wall of the skirt **321***b* and the jaw.

The mechanism is then in the declutched position shown in FIG. **15**, which is a section view on plane BB of the FIG. **16** mechanism, in which position, turning of the guide element **340** can no longer be transmitted to the cup **321** and thus to the inlet shaft **200** of the article-carrier.

Consequently, when the mechanism **320** is in the declutched position, external means, which are described below, intervene to turn the cup **321** and thus the inlet shaft **200** of the article-carrier when the article-carrier is in a particular indexed position of the turntable (flame cleaning, deducting, pre-registry, and registry).

It should be observed that two rolling means **350** and **352** are provided for rotary mounting about the hub **322**, as shown in FIGS. **14** and **15**.

It can thus be seen that the clutch mechanism passes from a clutched position to a declutched position and vice versa when the position of the guide element **340** along an axis perpendicular to the travel plane of the article-carriers varies, and when, as a function of this position, the article carried by the article-carrier is turned by said guide element via the clutch mechanism or by via different external means.

The guide element or roller **340** serves to guide the movement of the article-carrier on its circular travel following a guide path shown in FIG. **18**.

It should be observed that in a variant, the clutch mechanism could alternatively present a groove co-operating with an external roller for turning the outlet shafts of the article-carriers.

The plate **360** shown in FIG. **18** is for fixing on the stationary table **230** shown in FIG. **10** and which is not shown again in this figure for reasons of clarity.

Wall elements of curved shape are positioned on the plate **360** in pairs one after another along a path of generally circular shape and they are spaced apart from one another within a given pair, so as to leave between them a stationary path portion.

The guide path **361** thus comprises a succession of stationary path portions **362***a*, **362***b*, **364***a*, **364***b*, **366***a*, **366***b*, **368***a*, **368***b*, **370***a*, **370***b*, **372***a*, **372***b*, **374***a*, **374***b*, **376***a*, **376***b*, **378***a*, **378***b*, **380***a*, **380***b*, **382***a*, **382***b*.

The stationary path portions are locally interrupted opposite to predetermined zones, shown in FIG. **18** at openings **384**, **386**, **388**, **390**, **392**, and **394** coinciding respectively with openings **266**, **267**, **270**, **272**, **274**, **276**, and **278** in the stationary table of FIG. **10**, each serving to receive a moving path portion. More particularly, each moving path portion is mounted to turn about an axis perpendicular to the travel plane of the article-carriers, i.e. to the plane of the table **360**.

Each moving path portion arranged between two stationary path portions is mounted at the end of drive means that are described below and that turn the inlet shaft **200** of each article-carrier, and thus turn its outlet shaft **218** carrying the article that is to receive printing.

Such drive means are shown in FIGS. **19** and **20**.

FIG. **19** shows an actuator **400** forming part of the above-mentioned drive means and comprising a brushless motor **402** having, at one of its ends, an outlet shaft **404** constituting a drive shaft having a toothed pulley wheel **406** mounted thereon.

A cylindrical housing **408**, referred to as a drive carrier, has openings to give access to the elements it surrounds, and is mounted concentrically around the axis **404**, having a free one of its ends carrying a part **410** made up of two semicircular portions separated by a rectilinear slot **412**, said part **410** being constrained to turn with the drive shaft **404**.

The part **410** constitutes a moving path portion for insertion into one of the openings **384**, **386**, **388**, **390**, **392**, and **394** of the table **360** of FIG. **18**.

The turning part **410** is, for example, shown in FIGS. **21***a* to **21***g* disposed between fixed path portions constituted by paired wall elements **376***a* & **376***b* and **378***a* & **378***b* on either side of the opening **390**.

All of the moving path portions inserted in the above-mentioned openings in the table **360** of FIG. **18** are identical to the part **410** provided with the slot **412** shown in FIG. **19**.

Nevertheless, the drive means on which the moving path portions **410** are secured differ depending on the particular opening in the table.

More particularly, FIG. **20** is a perspective view from the underside of the table **360** of FIG. **18** in which the various drive means are arranged having respective drive axes for turning the inlet shafts **200** of the article-carriers in temporarily and local manner via, in succession, the moving path portion **410**, the guide element **340**, and the clutch mechanism **320**.

It should be observed that when the guide element **340** moves in the fixed path portions, i.e. between two indexed positions of the turntable away from the predetermined zones corresponding to the zones situated in the vicinity of the indexed positions, the index shafts **200** remain in the same angular position since they do not turn.

The stationary actuator of FIG. **19** is held in position by being fixed to the base **12** of the machine so that the moving path portion which is associated therewith is engaged in the opening **388** of the table **360**.

The actuator **400** is suitable for transmitting the turning movement of its drive shaft **404** to two drivers **420**, **422** via a cog belt **424** which turns the drive shafts corresponding to these two drivers **420** and **422**.

FIG. **17**, which is a view from the center of the turntable **14**, shows the driver **422** which comprises a driver carrier **426** of perforated cylindrical shape having mounted therein a drive shaft **428** perpendicular to the horizontal travel plane of the article-carriers and carrying top and bottom bearings (not visible in FIG. **17**).

A toothed pulley wheel **430** is mounted on the drive shaft **428** in order to receive the drive belt **424**.

At the driver, in register with a print head, an incremental coder **431** is mounted on the shaft of the driver to subdivide turning of the article into 20,000 points used for controlling the variable controller of the motor **402** of the actuator **400**.

This information is transmitted directly to the motor for moving the print screen which causes movement in translation over a perimeter of the article that is subdivided by 20,000 for one increment received from the coder.

This makes it possible to avoid being affected by slack in mechanical transmission upstream from the axis of the driver, e.g. due to eccentricity of the belt-pulley wheel.

This also makes it possible to increase or decrease the corresponding distance along the article merely by parameterizing the ratio between displacement and sensed increment.

It should be observed that an incremental coder **431** is provided for each of the assemblies comprising drive means at a print station or at a dryer station (FIG. **20**).

The driver **420** is identical in structure to the driver **422** of FIG. **17**.

It should be observed that the actuator **400** and the two drivers **420** and **422** serve to turn the articles while the corresponding article-carriers are situated in print stations.

This configuration makes it possible, advantageously, to use only one actuator for controlling the turning of the articles in the print stations.

An arrangement identical to that described above is provided for turning articles in the dryer stations, using an actuator **440** which transmits the turning movement of its drive shaft to two drivers **442** and **444** by means of a cog belt **446**, in a manner identical to that described above for the actuator **400** and the drivers **420** and **422**.

The drivers **442** and **444** are practically identical to above-described drivers **420** and **422** in terms of structure and operation.

In FIG. **17**, it can be seen that the driver **422** carries a moving path portion **410** at the end of the drive shaft **428** that is identical to that shown in FIG. **19** and that is centered on the drive shaft of the drive means under consideration.

It should be observed that the dimensions of the moving path portion in a horizontal plane, i.e. its diameter, are greater than the dimensions of the guide element or roller **340** so that they can co-operate with each other, as described below.

As described above, when the clutch mechanism **320** of an article-carrier is in the clutched position, turning of the drive shaft of the drive means situated beneath it causes the moving path portion **410** to pivot, which moving path portion has the guide element **340** received therein, thereby causing the cup **321** to turn and also causing the inlet shaft **200** of the article-carrier to turn.

Consequently, the outlet shaft **218** of the article-carrier which receives the mandrel **18** carrying the article is likewise caused to turn about its own axis.

In conventional printer machines, the article that is to receive printing or that is to be dried is turned when the turntable supporting the article-carriers is stopped in an indexed position corresponding to the article-carrier being positioned at a print station or a dryer station.

Nevertheless, the printer machine of the invention enables the inlet shaft **200** of an article-carrier to be turned even while the turntable **14** supporting the article-carriers is moving.

Such simultaneous movement is made possible when the article-carrier lies in a predetermined zone of its circular path, and in particular in the vicinity of the print stations and dryer stations in which the guide roll **226** is respectively in its high position H or its low position B.

This double movement is possible over a rising or descending path portion on either side of the position H (FIG. **11***b*) and over a descending or rising path portion on either side of the position B (FIG. **11***c*).

This angular position amplitude of the article-carrier is determined by the extreme positions of the guide element **340** inside the slot **412** (FIG. **17**).

It is possible for the inlet shaft **200** of the article-carrier and thus for the article itself to be turned so long as the guide element **340** is to be found in the moving path portion **410**, regardless of whether or not the inlet shaft **200** is in alignment with the drive shaft of the drive means in question.

FIGS. **21***a* to **21***g* show a moving path portion **410** (opposite to a dryer station) arranged between stationary path portions constituted by corresponding pairs of curved wall elements **376** & **376***b* and **378***a* & **378***b*, inserted in the opening **390** of the table **360** shown in FIG. **18**.

In FIG. **21***a*, there is shown the approach movement of the article-carrier, with the axis of the corresponding drive shaft passing via the point C**1**, while the point C**2** is the point through the axis of the shaft of the corresponding drive means passes.

In this first figure, the article-carrier is guided along a circular path by the guide element **340** which leaves a stationary path portion (**376***a* & **376***b*) to enter into the moving path portion **410**.

The corresponding displacement of the article-carrier is represented by the arrow referenced **480** and the point C**1** through which the axis of the inlet shaft **200** of the article-carrier passes moves towards the point C**2** through which the axis of the drive shaft of the actuator passes.

Starting from this position of the article-carrier for which the guide element **340** is guided in the slot **412**, the drive shaft of the corresponding drive means, in this case the actuator **440**, can be turned thereby, as represented by arrow **482**.

This turning movement causes corresponding turning of the article to be dried and is combined with movement displacing the article-carrier along its circular path, as represented by arrow **480**.

Since the actuator **440** is provided to control the turning movements of articles in the dryer stations, the corresponding movement of the article-carrier in order to reach a dryer station is downward pivoting, as shown in FIG. **11***c*, with the guide roll **226** heading towards the low position B in the guide path.

In the following FIG. **21***b*, the combined movement continues, with the point C**1** moving towards the point C**2** until these two points coincide as shown in FIG. **21***c*.

In the position shown in FIG. **21***b*, the guide roll **226** is in its low position B, as shown in FIG. **11***c*, and the article-carrier is thus in an extreme position.

The turning movement of the article continues in FIGS. **21***d* and **21***e* while the turntable and the article-carriers are stopped in an indexed position, with the movements of the drive shaft and the inlet shaft **200** then taking place at the same speed.

After some number of revolutions of the article, in this case an integer number, the drying operation is terminated and the guide element **340** is then to be found, for example, in the position shown in FIG. **21***e*.

It should be observed that the moving path portion **410** possesses an angular orientation relative to the stationary path portions which is such that the two successive path portions are not in alignment, thereby preventing the guide element from going from one to the other.

Starting from this position, it is therefore necessary to bring the moving and stationary path portions into alignment, with this taking place while continuing to turn the article in the direction shown by the arrow referenced **482** in FIG. **21***f* and **21***g*.

Simultaneously, the turntable restarts its own turning movement, taking with it the article-carriers which move as shown by the arrow referenced **486** in FIG. **21***f*, the point C**1** of the article-carrier then being moved away from the point C**2**, to the right in the figure.

It should be observed that in the prior art it is necessary to keep the turntable stationary while the driver and the guide are being brought back into alignment.

As shown in FIG. **21***g*, the turning movement of the moving path portion **410**, and thus of the article, comes to an end when the moving and stationary path portions are back in alignment, whereas the movement of the turntable and of the article-carriers continues, as is shown by the points C**1** and C**2** becoming ever further apart.

The guide element **340** will then shortly leave the moving path portion and enter the stationary path portion as defined by the curved wall elements **378***a* and **378***b*.

It can thus be understood that during turning of the turntable, and thus of the article-carriers, the articles can be made to turn in background time.

Thus, in anticipated manner, the article **300** shown in FIG. **11***c* is caused to turn before it penetrates into the slot **310** of the drying oven (FIG. **21***b*) and also at the end of the drying operation (FIG. **21***f*), with the article-carrier starting to move again, thereby distributing ultraviolet radiation in uniform manner around the periphery of the article.

The ability to cause the article to turn while it is approaching the slot **310** formed in the dryer oven makes it possible to avoid overexposure of the article to radiation, which is harmful to print quality.

Similarly, the combined movement in rotation and translation of the article also makes it possible to avoid underexposing certain zones thereof.

This makes it possible to avoid any need to over dimension the ovens in order to avoid having zones on the article which are underexposed to radiation.

Furthermore, the use of background time for turning the article while moving the article-carrier is also advantageous in the print stations, whether before or after printing.

In the print stations, there is sometimes a need to implement print extra print length that make it necessary, when printing all the way round an article, to begin the print operation before the beginning of the complete revolution and to continue the operation after the complete revolution has come to an end, with this being for reasons associated with the silk-screen printing technique.

FIGS. **22***a* to **22***h* show a moving path portion **410** (opposite to a print station) arranged between two stationary path portions constituted by corresponding curved wall elements **374***a* & **374***b* and **376***a* & **376***b*, inserted in the opening **388** in the table **360** of FIG. **18**.

For simplification purposes, the notation used in FIG. **21***a* to **21***g* is repeated in these figures for elements that are common thereto.

Opposite to the print station in question, the actuator **440** serves to control turning of the articles and to control the corresponding movement of the article-carrier to move into a print station is an upward pivoting movement, as shown in FIG. **11***b*, with the guide roll **226** traveling towards the high position H in the guide path.

It can thus be seen in FIGS. **22***a* to **22***c* that the movement of the article-carrier as represented by the arrow referenced

490 takes place simultaneously with turning of the moving path portion 410 (arrow referenced 492) and thus with rotation of the roller 340 and with turning of the article that is to receive printing.

The point C1 moves towards the point C2 until it coincides therewith in FIG. 22*c* which corresponds to the turntable being in an indexed position.

Turning movement of the article continues in FIGS. 22*d*, 22*e*, and 22*f*, and up to FIG. 22*g* where the roller 340, and thus the article, has performed more than one revolution, thus corresponding to a extra print length.

Starting from the position of FIG. 22*g*, the moving path portion 410 turns in the opposite direction, as shown by the arrow referenced 496, so as to bring this path portion into alignment with the stationary path portions, while the turntable starts to turn again, taking with it the article-carrier in question, as shown by the arrow referenced 494.

This causes the point C1 to move away from the point C2, and this movement continues in FIG. 22*h* where the moving path portion has the same angular orientation as the stationary path portions, thus allowing the roller 340 to leave the moving path portion.

It should be observed that the combined simultaneous movement is also advantageous when it is necessary to implement positioning corrections prior to beginning printing.

The need to correct the relative position of the print screen relative to the angular position of the article prior to beginning printing can be better understood with reference to FIG. 23 and also to FIG. 1.

Initially, an article is engaged on the mandrel 18 of an article-carrier 16 in a conventional loading station (not shown) which is disposed in register with the article-carrier referenced by the letter A in FIG. 1. The article-carriers referenced by the letters B and C are in positions which correspond respectively to the flame-cleaning and the deducting stations, operations that are preliminaries to printing and that will subsequently be performed on the article carried by the article-carrier presently situated at the loading station, once the turntable 14 has moved successively into the corresponding indexing positions.

The article-carriers identified by letters D and E are in angular positions corresponding respectively to the pre-registry station and to the registry station.

The article-carriers identified by letters F and G, and those identified by the letters H and I and J and K are in positions that correspond respectively to a print station and to a dryer station.

The article-carrier identified by the letter L is in a position corresponding to an article-unloading station.

There can thus be seen at the flame-cleaning and dedusting stations, and also at the pre-registry and registry stations, two arrangements that are practically identical and referenced 500 and 502 respectively, with only one such arrangement 500 being shown in FIG. 23.

This arrangement comprises two motor and gearbox units 504 and 506 each having its drive axis perpendicular to the travel plane of the article-carriers (the plane of the turntable 14).

These two motor and gearbox units are secured to a support plate 508 and their respective drive shafts pass therethrough and carry two respective drive wheels 510 and 512, the plate 508 being secured to a vertical upright 262 of the stationary table 230.

The drive wheels 512 and 510 serve to turn the cups 321 of the clutch mechanisms 320 of two article-carriers identified by letters D and E in FIGS. 1 and 23.

It should be observed that in this figure only a few of the article-carriers are shown, for simplification purposes.

The drive wheels 512 and 510 co-operate by friction with the outside portions of the skirt 321*b* of the cup 321 when the clutch mechanism is in the declutched position, as shown in FIG. 15.

This declutched position is obtained by varying the vertical positions of the rollers 328, 330 of FIGS. 14 to 16, and more particularly by causing these rollers to rise inside the cup 321.

This is done by additional means shown in FIG. 18 as the paired wall elements 362*a*, 362*b* which are of thickness that increases progressively going from one end to the other.

When the guide roller 340 moves inside the sloping stationary path portion defined by these wall elements, the rollers 328 and 330 of the mechanism 320 come into contact with the top portions of these wall elements and thus rise progressively, thereby leading, as described with reference to FIG. 15, to the wheels 324 and 326 moving from the inclined ramp 342 to the inclined ramp 344.

Once the jaw 336 is separated from the inside wall of the cup 321, the inlet shaft 200 of the article-carrier can then be turned by only one of the drive wheels 512 or 510 of FIG. 23, depending on the station in question.

It should be observed that the variation in the thickness of the wall elements constituting the above-mentioned stationary path portion, is arranged after the loading station and before the flame-cleaning station, corresponding in FIG. 1 to the angular positions of the article-carriers identified by letters A and B, respectively.

It should be observed that the clutch mechanism 320 of an article-carrier remains in the declutched position so long as the article-carrier travels along stationary path portions defined by respective wall elements 364*a* & 364*b* and 366*a* & 366*b*.

The stationary path portion defined by the wall elements 364 and 364*b* corresponds to the flame-cleaning and deducting stations, while the path portion defined by the wall elements 336*a* and 366*b* correspond to the pre-registry and registry stations.

When an article-carrier is at the registry station (article-carrier identified by the letter E in FIG. 1), the two rollers 328 and 330 of its clutch mechanism 320 overlie an actuator member 520 which has a U-shaped part 522 (FIG. 24) disposed at the end of an actuator 524, the two rollers 328 and 330 being placed respectively above the two limbs of the U-shape.

In this position, in the registry station, rotation of the article carried by the corresponding article-carrier is driven by the drive wheel 510 shown in FIG. 23.

Once the registry operation has been performed, and before the turntable begins to turn again, the actuator is lowered, thereby lowering the U-shaped part and thus enabling the rollers 328 and 330 to move down, thereby moving the clutch mechanism 320 as a whole into a clutched position as shown in FIG. 14.

When the clutch mechanism 320 of an article-carrier is in the declutched position and the corresponding article-carrier is in the pre-registry station of FIG. 23, the pre-registry motor 506 is caused to turn until reaching a cell or an identifier or a mark on the article that is to receive printing, so as to bring the article by appropriate turning into an angular position that is close to the position in which it needs to be for the printing operation.

Thereafter, the article-carrier is moved by the indexed turning of the turntable to the registry station where the registry motor 504 serves to position the article, to receive

printing in an accurate angular position so that the subsequent printing operation can start at the desired location on the outside surface of said article.

Nevertheless, it can happen that after an article has been put into its registered position for printing, the relative angular position of the article relative to the print screen is still not the desired position.

This can be detected, for example by a camera system which, on viewing the image of the angular position of the article at the end of the registry stage compares said image with a reference image representing the angular position that is desired for said article prior to the printing operation.

On the basis of this comparison performed by an electronic processor unit, the unit can deduce an angular correction to be applied to the article before beginning printing.

Under such circumstances, using the combined turning movement of the article while it is being moved in translation, while the turntable is turning, it is possible to perform said angular correction before the printing operation starts.

Thus, for equal cycle shares, i.e. in terms of turntable stop time and time during which the turntable is in movement, the use of combined movement both in turning and in translation of the article that is to receive printing makes it possible to increase quite considerably the time that is available for the printing and drying operations proper.

It can thus be said that for given printing speed and printing and drying characteristics, the throughput of the printer machine of the invention is increased relative to the throughputs of prior art machines.

For example, the printer machine of the invention enables 6000 articles to be processed per hour using printing speeds that are equivalent to those of a machine of known type, such as, for example, the machine described in document FR 2 782 292, which operates at a rate of 4000 articles per hour, only.

The machine of the invention can thus dry 6000 articles an hour, as explained in document FR 2 789 933, under the same conditions of ink deposition and speed of polymerization as those used in the machine described in document FR 2 782 292 whose throughput is only 4000 articles per hour.

It should be observed that the printer machine of the invention also includes a compressed air feed system which, by means of appropriate mechanical members (manifolds with control members, suction cups, . . .) and suitable trigger devices, enables the holding or release of articles on the article-carriers and the holding or release of said articles to be controlled by means of air suction.

What is claimed is:

1. A printer machine for printing on articles, comprising a plurality of article-carriers **(16)** which are suitable for moving in indexed manner in at least one plane and following a circular path, each article-carrier being stationary in an indexed position and mobile between indexed positions, and a plurality of stations, in particular for printing, distributed around the path opposite to indexed positions of the article-carriers, the machine being characterized in that each article-carrier **(16)** is fitted firstly with an inlet shaft **(200)** suitable for being turned about its own axis, in temporary and local manner by drive means each provided with a drive shaft, and secondly at least one outlet shaft **(218)** for carrying an article and suitable for turning when said inlet shaft is driven in rotation about its axis, said inlet shaft and each article-carrier being suitable for being turned about its own axis by said drive shafts opposite to the indexed positions, said inlet shaft being suitable for retaining the same angular orientation between print stations, the drive shaft of the drive means and said inlet shaft of each corresponding article-carrier being mutually parallel and disposed perpendicularly to the travel plane of the article-carrier.

2. A printer machine according to claim **1**, characterized in that said inlet shaft of each article-carrier is also suitable for being turned by the drive means when the article-carrier in question is moving through one or more predetermined zones of the circular path.

3. A printer machine according to claim **2**, characterized in that the predetermined zone(s) of the circular path corresponds to zones situated in the vicinity of indexed positions opposite to print stations.

4. A printer machine according to claim **1**, characterized in that it includes an indexed turntable **(14)** on which the article-carriers **(16)** are mounted, the turntable being mounted to turn about its central axis on a base.

5. A printer machine according to claim **4**, characterized in that the drive shaft of the drive means is stationary relative to the base.

6. A printer machine according to claim **4**, characterized in that it includes means for causing the turntable **(14)** to turn, which means are different from the means for turning the inlet shafts of the article-carriers.

7. A printer machine according to claim **1**, characterized in that, for each article-carrier, it includes a guide element **(340)** connected to the inlet shaft **(200)** of the article-carrier and suitable for moving along a guide path **(361)** which is concentric relative to the circular path of said article-carrier.

8. A printer machine according to claim **7**, characterized in that the guide path **(361)** comprises a succession of path portions locally interrupted opposite to predetermined zones, in each of which a corresponding path portion **(410)** located between two stationary path portions, is mounted to turn about an axis perpendicular to the travel plane of the article-carriers such that, depending on the angular orientation of the moving path portion relative to the stationary path portions, the guide element **(340)** is free or not free to move from a stationary path portion to the moving path portion, or vice versa.

9. A printer machine according to claim **8**, characterized in that each moving path portion **(410)** is arranged in centered manner on the drive axis of the drive shaft of the drive means.

10. A printer machine according to claim **7**, characterized in that the guide element **(340)** is suitable for being turned by the drive shaft of the drive means and is suitable for transmitting this turning movement to the inlet shaft **(200)** of an article-carrier while the article-carrier in question is moving through one or more predetermined zones of the circular path.

11. A printer machine according to claim **8**, characterized in that the guide element **(340)** is suitable for being turned while it is co-operating with a moving path portion **(410)**.

12. A printer machine according to claim **7**, characterized in that the guide element is a roller.

13. A printer machine according to claim **12**, characterized in that the roller moves inside a slot **(412)** in the moving path portion **(410)**, the path followed by said roller being shorter than the dimensions of the slot.

14. A printer machine according to claim **7**, characterized in that it comprises, for each article-carrier **(16)**, a clutch mechanism **(320)** disposed between the inlet shaft **(200)** of the article-carrier and the drive shaft of the means for driving said article-carrier, which clutch mechanism, depending on the clutched or declutched position it adopts, serves to allow the article to be driven in rotation either via the guide element **(340)** or by some other means.

15. A printer machine according to claim 14, characterized in that the clutch mechanism (320) comprises at least two rollers (328, 330) and changeover from a clutched position of said clutch mechanism to a declutched position is triggered depending on the position of said at least two rollers along an axis perpendicular to the travel plane of the article-carriers.

16. A printer machine according to claim 4, characterized in that the drive means of at least a plurality of article-carriers comprise at least a stationary actuator (400) suitable for transmitting turning movement to the respective drive shafts which are suitable for turning the inlet shafts of said article-carriers.

17. A printer machine according to claim 16, characterized in that the actuator is a brushless motor (402).

18. A printer machine according to claim 17, characterized in that the brushless motor (402) includes a variable control circuit which is controlled by at least one incremental coder.

19. A printer machine according to claim 18, characterized in that the incremental coder determines the phase of the movements of the article-carrier drive means with great accuracy relative to the phase of the indexed rotary turntable (14) on which said article-carriers are mounted, by means of an absolute coder (23) secured to the slow shaft of the gearbox of the means for indexing said turntable.

20. A printer machine according to claim 16, characterized in that it includes a plurality of stations for drying printed articles, which stations are arranged on the article-carrier path, each opposite to an indexed position of an article-carrier following an indexed position that has a print station arranged opposite thereto.

21. A printer machine according to claim 20, characterized in that a single actuator (400) is provided to control the turning movement of articles when the corresponding article-carriers are in the indexed positions having the print stations arranged opposite thereto, a single actuator (440) being provided to control the turning movement of the articles when the corresponding article-carriers are in the indexed positions having the dryer stations arranged opposite thereto.

22. A method of operating a printer machine for printing on articles, the machine having a plurality of article-carriers which are adapted to move in indexed manner in at least one plane and following a circular path, the printer machine having a plurality of stations, in particular of print stations, distributed around said path opposite to indexed positions of the article-carriers, the machine being characterized in that each article-carrier (16) is fitted firstly with an inlet shaft (200) suitable for being turned about its own axis in temporary and local manner, and secondly with at least one outlet shaft (218) for carrying an article and suitable for turning when said inlet shaft which is perpendicular to the travel plane of the article-carriers is caused to rotate about its axis, the method comprising the following steps:

driving the article-carriers around their plane circular path between two indexed positions away from the vicinity thereof, while the inlet shafts of each article-carrier is not being turned about its own axis;

driving the article-carriers around their plane circular paths when they are in the vicinity of their indexed positions;

turning the inlet shafts of the article-carriers about their own axes when they are in the vicinity of some of their indexed positions, while the article-carriers are also being driven in rotation; and

driving in rotation the inlet shafts of article-carriers about its own axe while the article-carriers are at rest in their indexed positions.

23. A printer machine according to claim 1, characterized in that the drive means of at least a plurality of article-carriers comprise at least a stationary actuator (400) suitable for transmitting turning movement to the respective drive shafts which are suitable for turning the inlet shafts of said article-carriers.

24. A printer machine according to claim 1, characterized in that it includes a plurality of stations for drying printed articles, which stations are arranged on the article-carrier path, each opposite to an indexed position of an article-carrier following an indexed position that has a print station arranged opposite thereto.

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